SEPTEMBER 1977 $1.00

Popular science

The What's New magazine

DROUGHT
What new research reveals about our changing weather

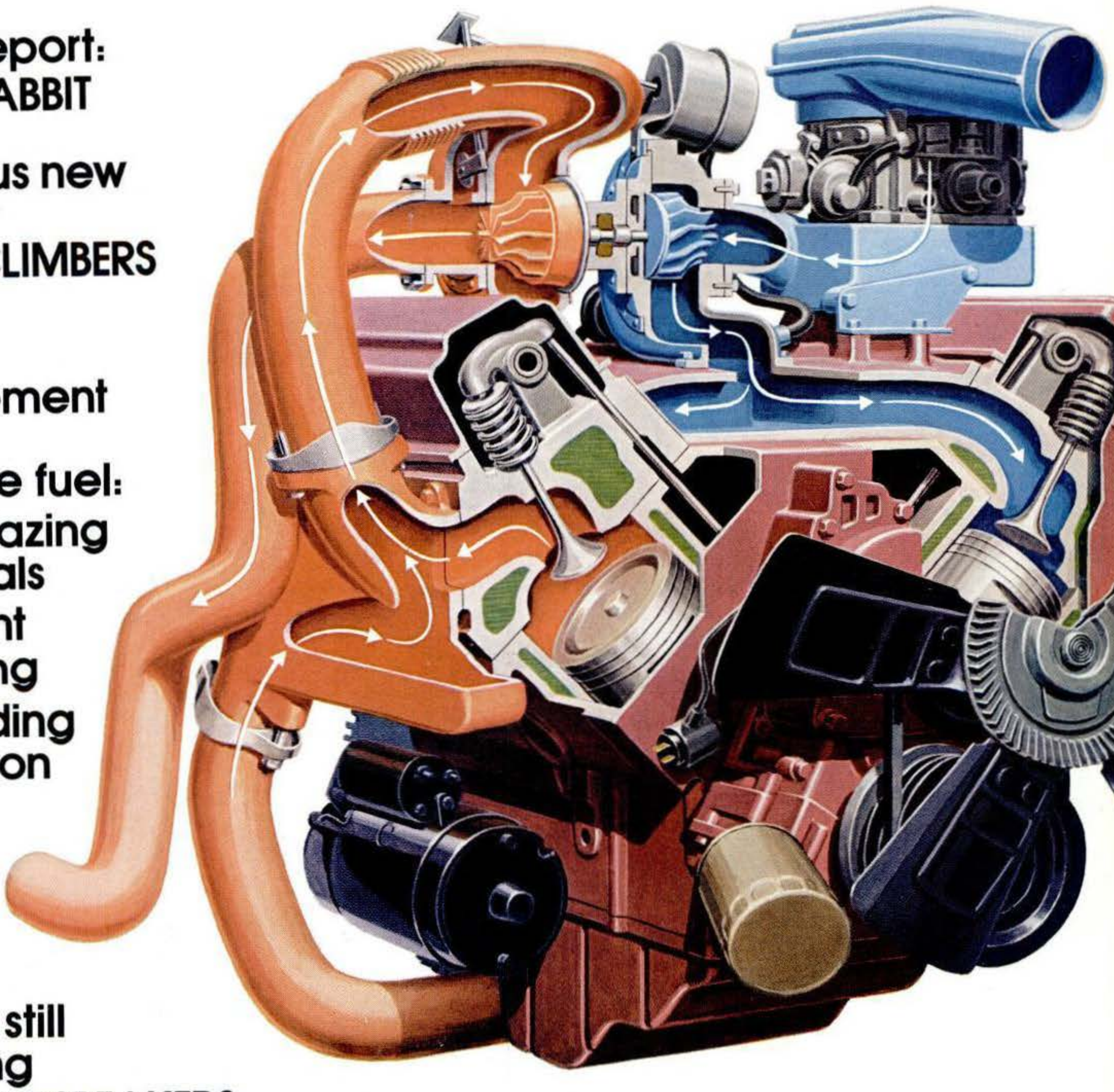
Buick's turbocharged V6
Is it the engine of the '80's?

PS test report:
DIESEL RABBIT

Ingenious new gear for ROCK CLIMBERS

Home-improvement ideas that save fuel:
- New glazing materials
- The right re-siding
- Upgrading insulation

They're still inventing HI-FI LOUDSPEAKERS



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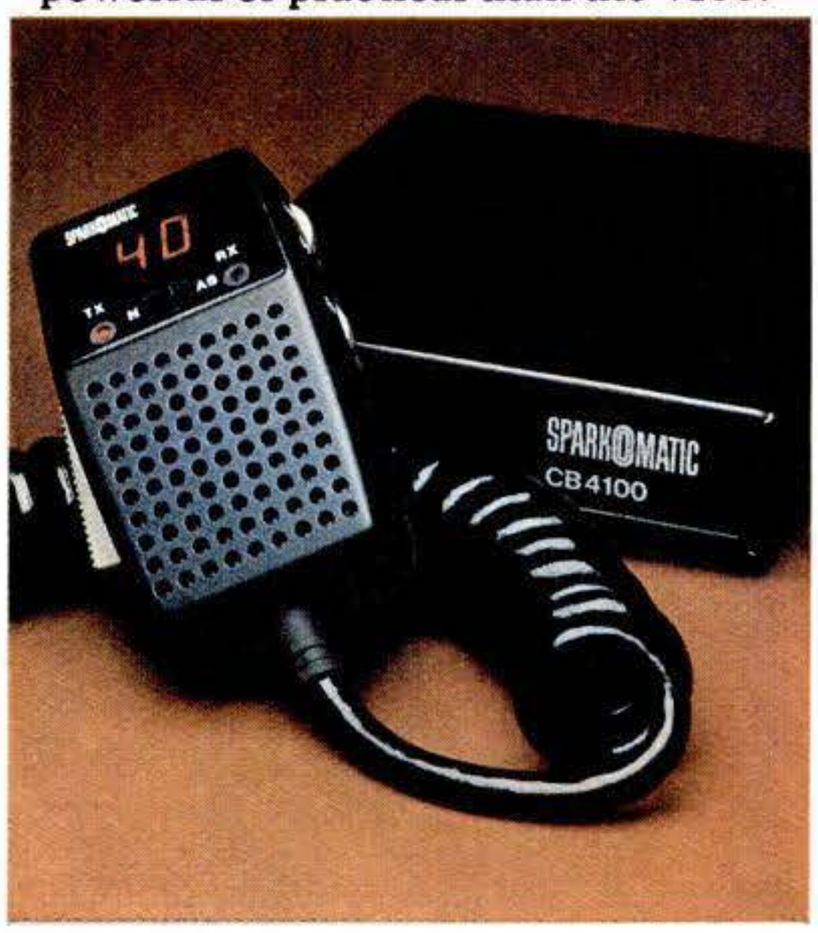

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Popular Science MONTHLY®

The What's New magazine

SEPTEMBER 1977
Founded in 1872/Vol. 211, No. 3

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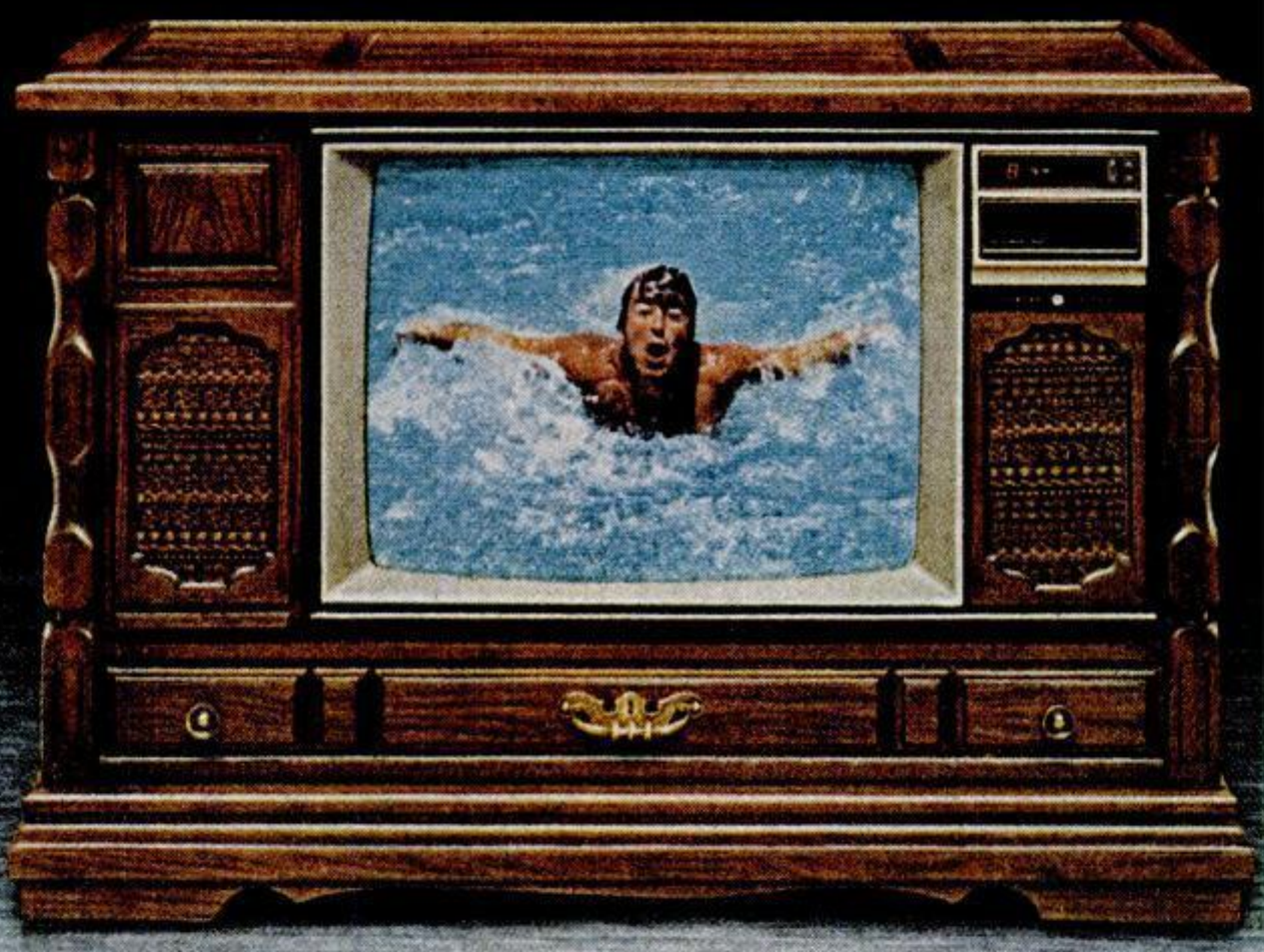

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PS READERS TALK BACK

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Low-technology resource recovery

In "Garbage—Refuse or Resource?" [June], Mort LaBreque details several high-technology methods for the separation and recovery of waste materials, or their conversion into energy.

Sounds hopeful, but I was very disappointed that he, like most Americans, chooses to overlook the simplest and most productive of all recovery systems: home separation. I get the feeling LaBreque and most government officials think it is un-American to use low-technology solutions to problems.

By casually tossing waste paper, cans, and glass into one garbage can (instead of casually tossing them into three or four containers for recycling), we citizens necessitate the development of very expensive, energy-intensive systems that cannot achieve the level of recovery possible through simple home sorting.

Specifically, paper fiber is damaged or destroyed by the wet or dry mechanical sorting techniques, and, of course, it is totally lost in pyrolysis or simple burning. Sure, some energy is recovered, but the energy used to produce it originally is lost (because now *new* paper must be processed to replace it), and new trees must be grown to replace the lost fiber.

There is no reason why existing sanitation departments cannot be easily converted for the neighborhood collection of home-sorted waste materials. I have seen community recycling centers succeed through the voluntary home sorting of "trash" by interested individuals. I think the general public is far more prepared for home-sorting than industrial and governmental leaders give them credit for.

Nathaniel Batchelder,
Oklahoma City, Okla.

Dam with a twist?

The "Bridge With a Twist" [PS, June] truly would be spectacular and maybe it would be earthquake-resistant. But shouldn't we ask the Bureau of Reclamation whether the dam, which makes the bridge necessary, is also likely to survive earthquakes?" . . . The area is seismically active," says the article.

I'm glad that I don't live downstream.

W. F. Spanke, Springfield, Va.

"Weed Eater" is *not* generic

"Weed Eater" is the registered trademark of Weed Eater, Inc., and identifies products [made only by that company], not the products of others. In the May issue, an article on string trimmers erroneously stated that all such trimmers are called Weed Eaters.

Frank S. Vaden III, Attorney,
Houston, Tex.

Floating decimal

Thank you for the fine coverage of the deck-remodeling project in your June issue. There is one item in the article that was incorrect. The Wolmanized lumber was treated to a 0.25-lb.-per-cu.-ft. retention of Wolman salts, not the 2.5 lb. as stated in the text.

Gerald B. Wellner,
Manager of Product Information,
Koppers Co., Inc.,
Pittsburgh, Pa.

Caution on record care

Harry Maynard, in his article on record care in the June issue, suggests inspecting records using a high-intensity lamp. I should like to suggest a word of caution, based on an unfortunate personal experience. These lamps put out a concentrated, high level of infrared heat, which, combined with the absorption of the black record, can quickly raise the temperature of a small area to a point where the record is permanently damaged.

James O. Spriggs, Kensington, Md.

Correction: Riblet RV Products, maker of the Kool-It console cooler [What's New for Your Car, July], gave us the wrong price by mistake. Suggested retail price of the Kool-It is $99.95.

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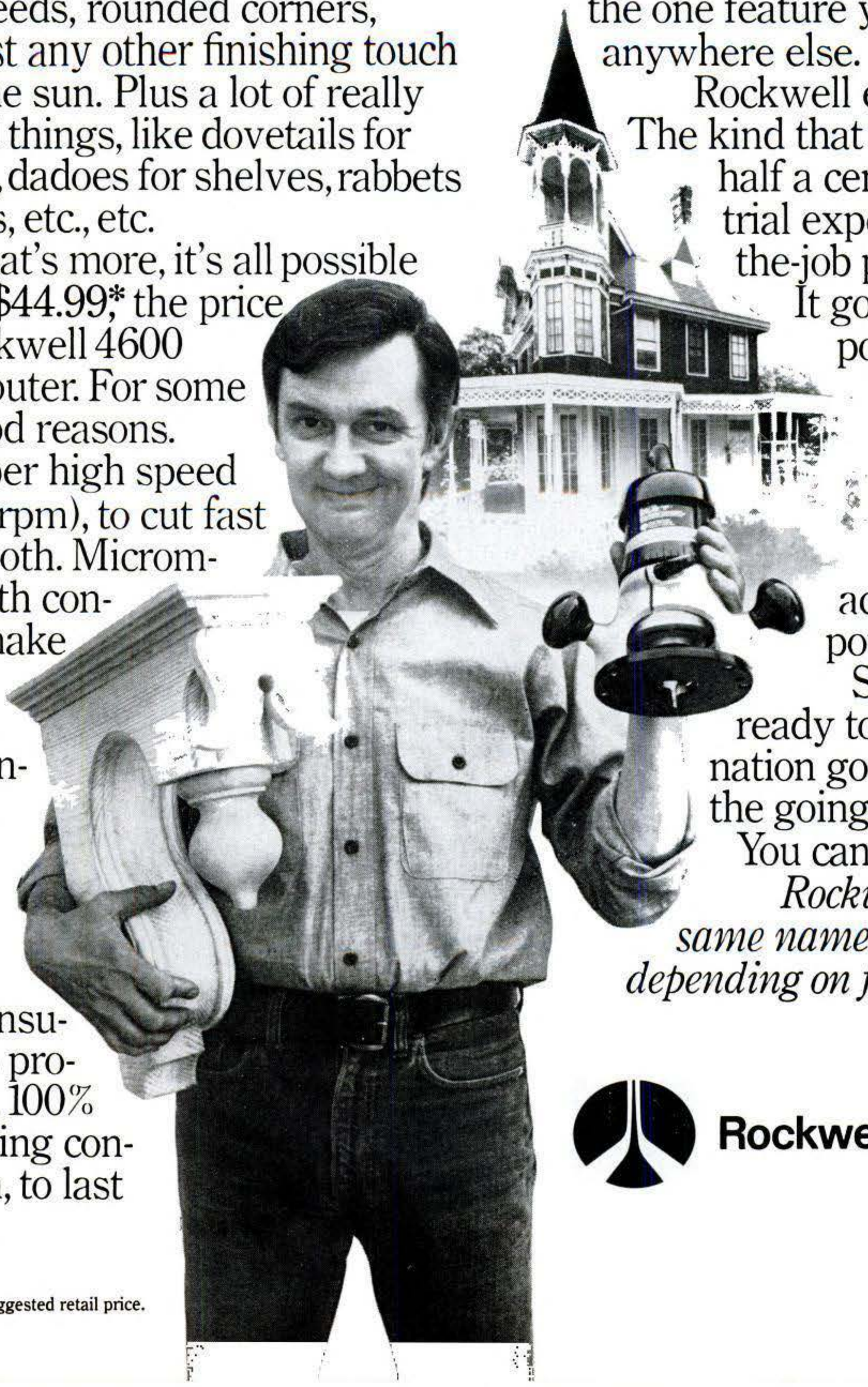

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RECREATION ROUNDUP

By HERBERT SHULDINER

President Carter and the environment

The problem of what to do about off-road vehicles and their impact on the environment has been growing for years. Lots of environmentalists want them banned from vast tracts of government land because of their potential environmental impact. But the government has been reluctant to take this action.

It seemed, though, a few months ago, that a tougher stance was going to be implemented. When the snowmobile industry and other off-road vehicle makers got word of this, they unleashed a mail blitz and a lobbying campaign in Congress that resulted in a complete halt in the government plans.

President Carter confirmed this in his environmental message to Congress last spring. There will be no wholesale ban on off-road vehicles on government land. In fact, as outlined in the President's message, there will be no changes of any consequence.

Apparently, the organized effort of off-road-vehicle owners has made the government back down. The pressure came in the form of some 12,000 letters to the Dept. of Agriculture and 80,000 to the Dept. of Interior. Thousands more were sent directly to the White House. Most were from ORV owners opposing any ban. The revised policy is likely to stand—unless deer and rabbits learn to write letters or are made eligible to vote.

Federal bucks for bikeways

Two bills are pending in Congress that would result in greatly increased bikeway construction. Sen. Robert Packwood of Oregon has asked for $45 million to build bikeways. Rep. Edward Koch of New York has introduced a similar bill in the House.

In calling on Congress to enact his bill, Sen. Packwood said that Congress provided $51 for each car, truck, and bus in the country—" . . . machines which pollute the air, clog our streets, and have been the primary reason for the energy crisis."

Packwood says only 12½ cents per bike is spent to encourage use of this vehicle. The $45 million would provide 55 cents per bike.

"Bikeways need to be built for transportation purposes," Packwood says, "because bikes are no longer just the toys of children."

Tent rentals

Kampgrounds of America, which got its start catering to big recreational vehicles, has put out a welcome mat for tent campers. The energy and economy problems in the country have apparently convinced KOA that the number of tenters will be increasing in coming years. Don Ryan, KOA's vice-president, says part of the reason will be a switch to smaller cars and a desire to conserve fuel.

KOA is not only welcoming campers who have their own tents, but has an ambitious rental program in operation at its more than 800 locations in the U.S. and Canada. For about $11 per night, you can rent a nine-by-12 tent with four cots or air mattresses.

One distressing sign of the times is that crime doesn't take a holiday even in campgrounds. KOA is providing locked storage boxes at campsites so campers can lock their valuables inside when they're away from their tents.

You can get a free folder giving tent-rental locations by sending a stamped, self-addressed envelope to KOA, Box 30558, Billings, Mont. 59114.

Lightning and outdoorsmen

If you're out camping, bicycling, or riding a motorcycle when a thunderstorm approaches, it's wise to get indoors until the storm passes, warns the National Oceanic and Atmospheric Administration (NOAA). About 7000 people have been killed by lightning since 1940, and many of these deaths could have been avoided with a few precautions, NOAA says.

If you're caught and can't get inside, here's what NOAA advises:

- Don't stand under a lone tree in an open area.
- Don't project yourself above the surrounding landscape.
- Get off motorcycles, bikes, or golf carts, and don't carry golf clubs.
- Stay away from wire fences.
- Spread out if you're with a group of hikers or climbers.

Swimming safety

Dr. Harris B. Stewart, an oceanographer with NOAA, has some good advice for swimmers trapped by a rip current. This is a strong narrow outflow of ocean water moving away from the shore. Swimmers caught in such water frequently get exhausted trying to fight their way through the tide toward shore. It can be a fatal mistake.

Cautious swimmers can learn to cope with this danger, says Dr. Stewart. The best thing is to recognize rip currents and avoid them. But if you're caught in one, swim parallel to the beach. The reason? Rip currents are rarely more than 10 to 20 feet wide; when you swim parallel to them, you'll soon get free and can then turn to shore.

New trends in towing vehicles

Surprisingly, little travel trailers are not picking up in popularity, despite the rising cost of fuel and President Carter's warning about gas-guzzling vehicles. What's more, cars are getting smaller and can't tow big trailers as they've been able to in the past. But big trailer sales just keep rolling along as if there's no energy crisis. What do you tow them with, though? Many trailer owners are using vans and pickups.

There's already been a proliferation of van-towing modules—specially set-up vans for pulling big trailers. Now Holiday Rambler, one of the biggest trailer makers, is introducing a six-passenger crew-cab pickup to do the same thing. The pickup is gussied up and has the same decor as the trailer. It's fully carpeted inside, even the walls and ceiling. Seats are plush, the dash is customized, and there's a small refrigerator in the console for keeping drinks cool. The exterior of the truck is painted to match the trailer it's designed to mate with.

Things to write for

- A complete RV-components catalog is available from ITT Jabsco Products, 1485 Dale Way, Costa Mesa, Calif. 92626. It's a guide to water systems, pumps, air compressors, water regulators, and other accessories.
- "The Way to Go" is a new booklet with basic RV information that can help you choose a motorized camper. It's also got answers about financing, insurance, campgrounds, and RV clubs. You can get a copy for $1 from Recreation Vehicle Industry Association, Box 204, Chantilly, Va. 22021.
- "How to Build Recreation Vehicles" is a new book by Clinton Hull with over 400 photos of how to make motor homes, trailers, and van conversions. It's available from Trail-R-Club of America, Box 1376, Beverly Hills, Calif. 90213, for $9.95.
- "How to Drive, Pull and Travel in RV's" by Robert and David Nulsen tells how to pull trailers or drive big motor homes. The authors also explain how the things in RV's work. It's $6.95, also from Trail-R-Club of America.
- "The Fisherman's Catalog" by Vlad Evanoff is a comprehensive guide to fresh and saltwater fishing. There are equipment guides and lots of information on where to buy the things you need for fishing. Published by Doubleday & Co. (245 Park Ave., N.Y., N.Y. 10017), it's $6.95. PS

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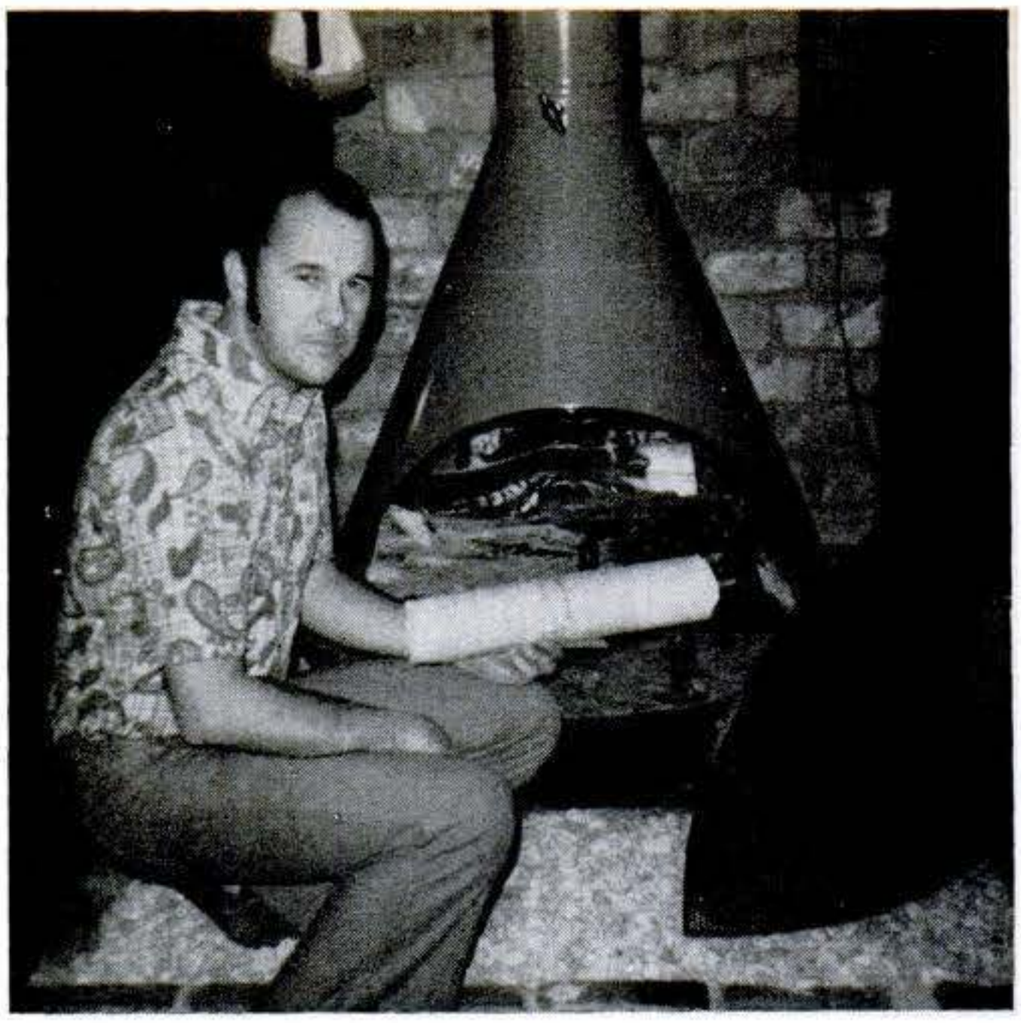
ADVENTURES IN ALTERNATE ENERGY

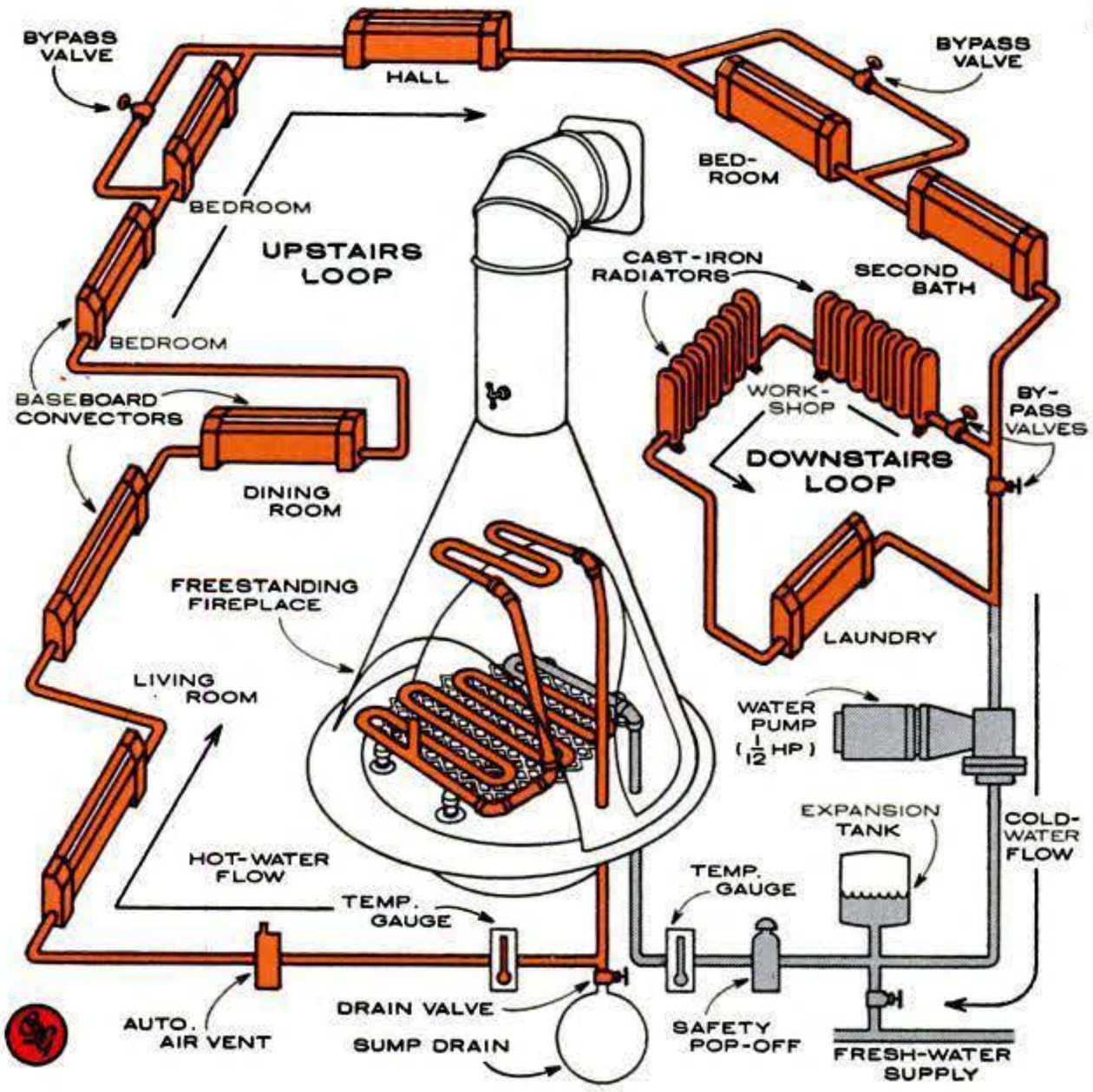
A monthly sampling of projects PS readers have devised to conserve or replace fossil fuels

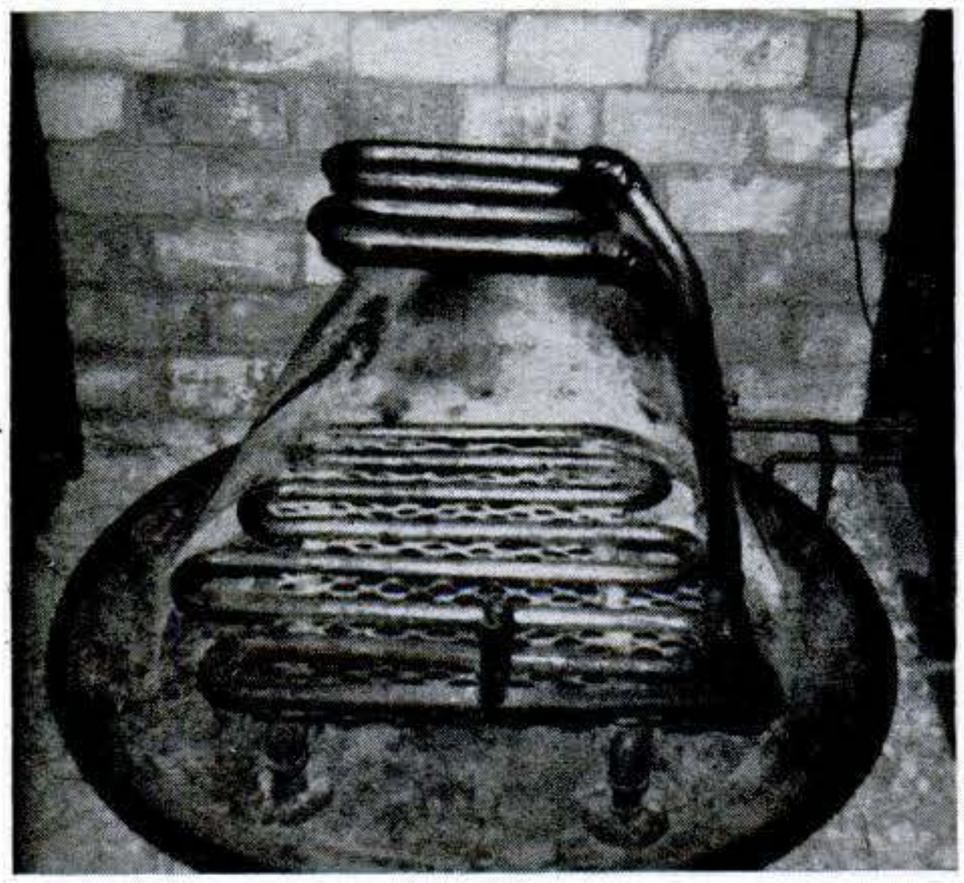
Thomas P. Powell

Freestanding fireplace

feeds baseboard heaters







Inventor Powell kindles fire in early morning; water temperature reaches 72° within an hour. View of grate with hood removed shows upper loop designed to capture hot flue gases usually lost up chimney. Two pipe unions outside the fireplace enable the entire grate to be lifted out for maintenance.

By EDWARD MORAN

Even before the energy crisis became apparent, the cone-shaped freestanding fireplace had already become a fixture in many households, though perhaps more as a decorative appliance than as a serious heat producer.

A lot of homeowners have since made such a fireplace an integral part of their domestic energy systems. But Thomas Powell didn't stop there: He adapted his unit to provide hydronic baseboard heating of his entire ranch-style home (four bedrooms, two baths, full basement) in Pasadena, Md.

The angst of an all-electric home narrowed the options for Powell two years ago, when he decided that a $350 investment in materials would bring an immediate reduction in electrical demand. "I did not have the advantage of being able to use an existing hot-water system in part," Powell says.

Making the grate

Using ¾" black iron pipe, Powell added a four-loop top section (see illustrations) above the original eight-loop bottom section of the fireplace. This top loop is designed to catch hot gases before they are lost up the flue. All copper tubing runs are insulated to prevent heat loss.

The downstairs loop, which heats laundry and workshop, consists of one large and two small cast-iron radiators. The upstairs loop consists of hot-water convectors (25,560 Btu) and receives hot water directly from the fireplace. Either loop can be shut off by means of bypass gate valves. Two bedrooms are also equipped with bypass valves so temperatures can be lowered for comfortable sleeping.

Powell admits the difficulty of regulating the heat output of the fireplace at the grate: The fire can't be turned up or down at the flick of a switch. Therefore, he uses the downstairs loop as a heat sink if upstairs temperatures become uncomfortable. Powell reports that, by diverting water to the cast-iron radiators, he can reduce the upstairs temperature by as much as 30 degrees in less than 10 minutes.

Temperature data

Powell didn't install the top four-

Continued

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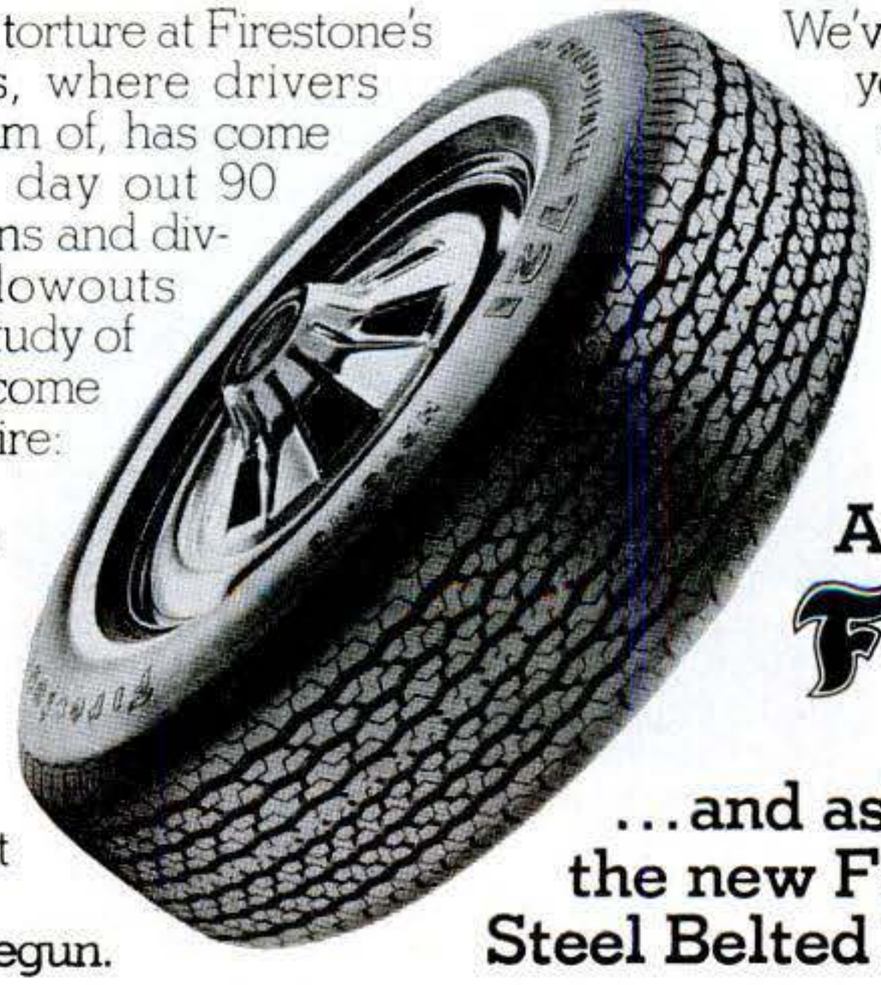
From five million miles of testing and torture at Firestone's Developmental Proving Grounds, where drivers do things to tires you shouldn't dream of, has come a special new tire. From day in, day out 90 mph speeds, from slamming into turns and diving into water, from deliberate blowouts and long agonizing hours of careful study of test after test...from all of this has come Firestone's finest steel belted radial tire: the Firestone 721.

Why did 721 steel cord come on so strong? It uses ten strands of steel, where five were used before. And we've wound it differently than before. With seven strands around two strands, and one other wrapping up the pack...the new twist that gives our tire its name.

Our journey's over, yours has just begun.



We've tortured out the secrets to bring you tires that work hard and long and well. If you'll remember that the safety of any tire depends on wear, load, proper inflation and driving conditions, you'll take advantage of *everything* five million hard miles have taught us.

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CASE XX

The Quality Cutlery Makers

W. R. Case & Sons Cutlery Co., Bradford, Pa. 16701.

Freestanding fireplace

[*Continued*]

loop grate until last heating season. During the first winter of operation, when just 32 feet of convectors were in use, "160° water temperature was not difficult to maintain," Powell says. He monitored temperature of both outgoing and incoming (return) water, and found the returning water was usually about 12 degrees colder. Heating bills for the 1975-76 season were $212 lower than the previous year's, even though the rate per kilowatt hour had increased. In 1976-77, with the upper coils and additional convectors—and a much colder winter—Powell was able to reduce his electric heating bills even more.

Hot air rises . . .

There's more to this system than hydronics: Air convection plays a minor but important part. In the dropped ceiling over the fireplace, Powell installed four two-by-four-ft. eggcrate light panels; in the floor of the master bedroom immediately above, he installed a one-ft.-square register and a muffin fan. Heat that normally rises to the ceiling in the den is thus circulated to the second floor.

The heating system is wired to operate either manually or automatically. In the former mode, the circulating pump is turned on or off at will. Or, a thermostat will open a relay when water temperatures reach 90°, turning on the pump. As the fire dies down at night, the thermostat will cut off the pump at 80°. In case of thermostat failure, the pump comes on, insuring continued water circulation.

All this presupposes, of course, that the freestanding fireplace has been installed according to safety standards, with proper clearances and facings. To ask a specific question, send a stamped return envelope to Thomas P. Powell, 7689 Oak Lane, Pasadena, Md. 21122. PS

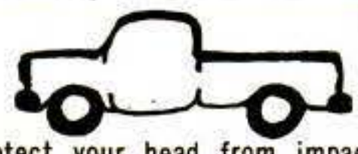
Your idea may bring you $200

Each month, we'll present a project developed by a PS reader and pay the inventor $200. Ideas not suitable for this series might be purchased at regular rates for use elsewhere in the magazine.

To enter, send us black-and-white glossies (one photo should show you demonstrating your device) plus pertinent text and sketches. Write your name, address, and Social Security number on each item. No material can be returned unless you enclose a stamped, self-addressed envelope.

Since space won't permit us to present projects in detail, we'll expect inventors to answer any reasonable query from readers if it's accompanied by a stamped envelope.

Mail entries to Energy Adventure, Popular Science, 380 Madison Ave., N.Y., N.Y. 10017.



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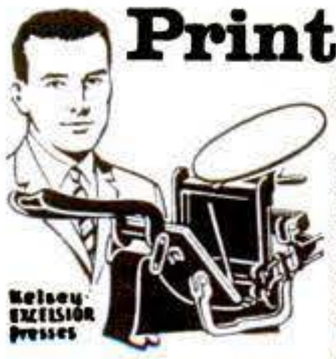

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The Few. The Proud. The Marines.

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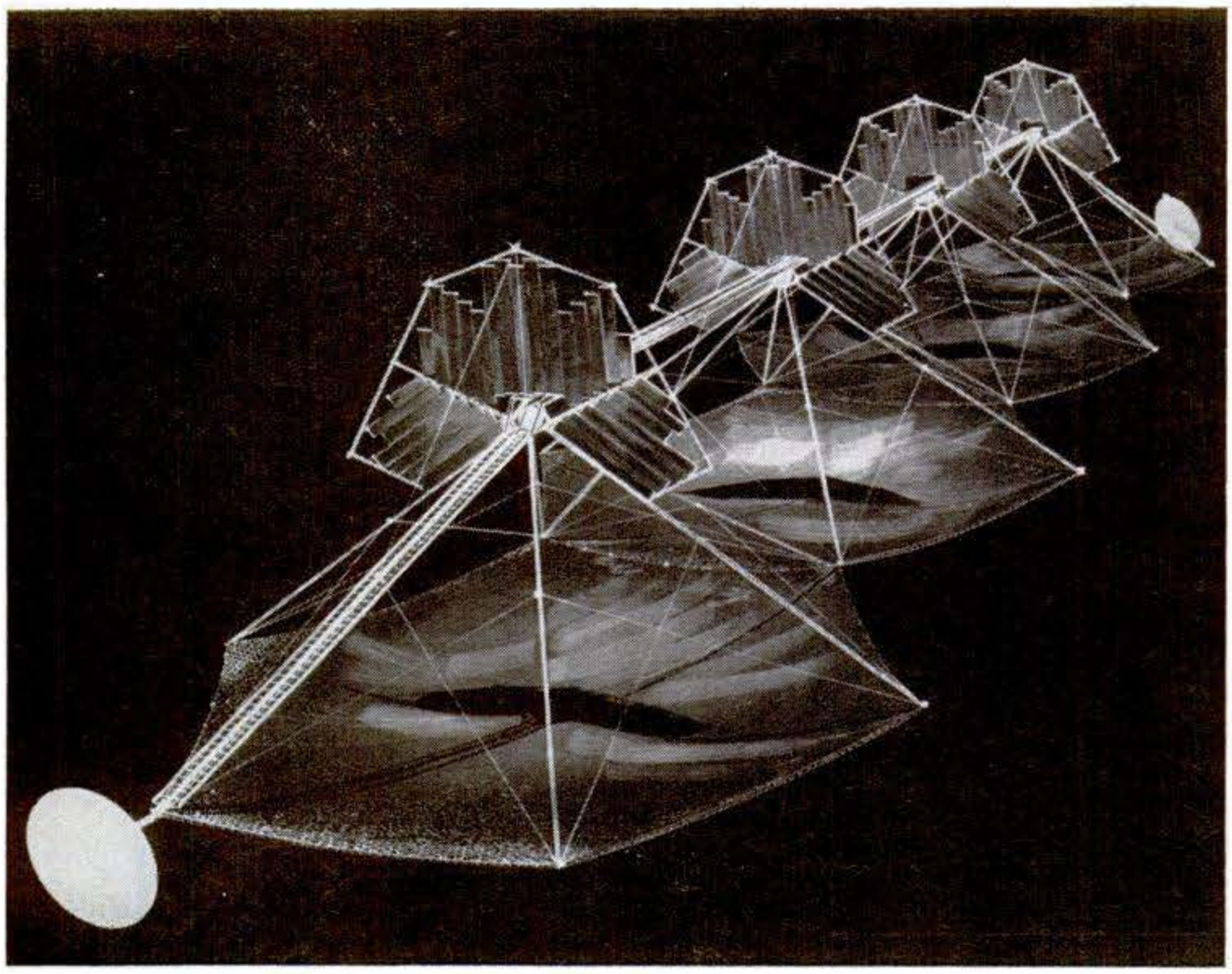
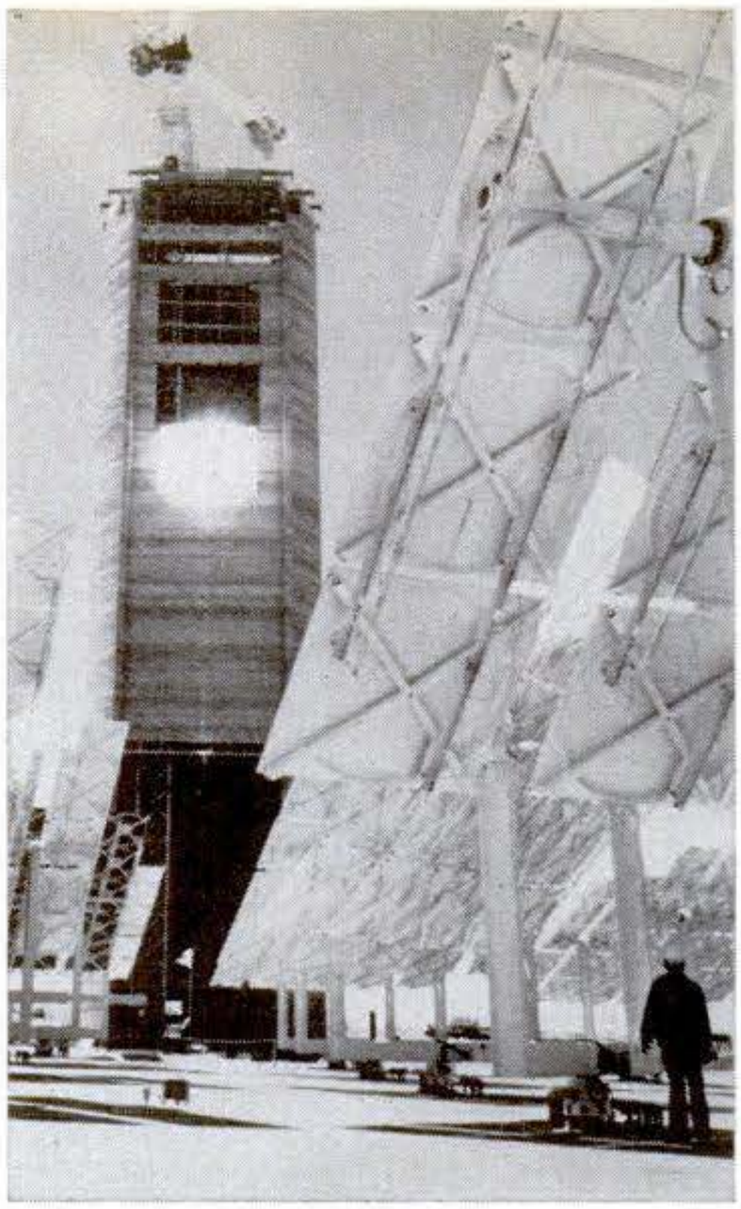
SCIENCE NEWSFRONT

BY ARTHUR FISHER



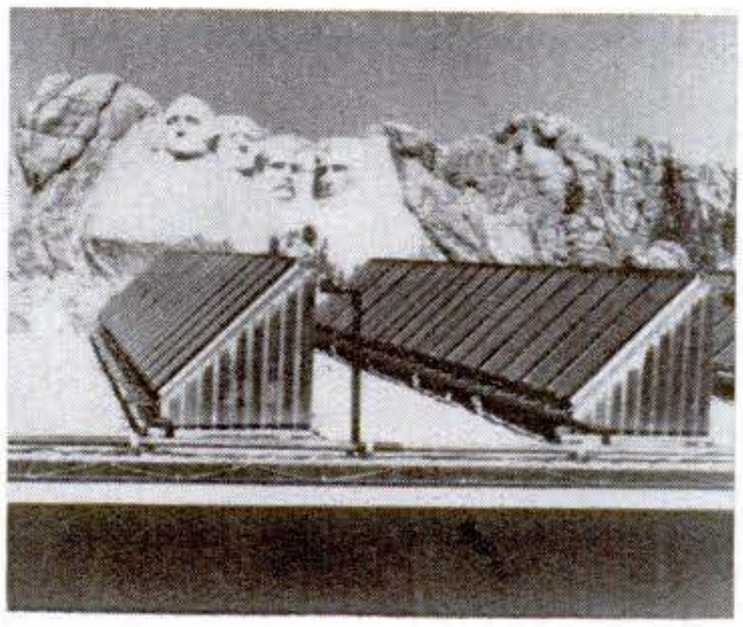


Grand solar-energy roundup

By coincidence, every picture in this month's Science Newsfront relates directly or indirectly to that most prodigious of energy sources, the sun. Above you see an artist's concept of harnessing this energy on a vast scale: a solar-power satellite the size of a small city. In this Boeing Aerospace Company concept, the satellite would use a series of four parabolic dishes, each about 5.6 kilometers across and consisting of thousands of steerable, ultra-thin plastic reflectors. Sunlight would be focused by each dish onto its own solar furnace, where superheated gases would expand and drive a series of turbogenerators. The electricity generated by such a satellite would be enough to supply about a million homes—10,000 megawatts. This power would be beamed from the satellite's 36,000-kilometer-high geosynchronous orbit down to Earth in the form of microwaves, transmitted from the round antennas seen in the picture. Forty-five of these power satellites would match the total U.S. electrical output.

Rushmore goes solar

Not the whole mountain, just the visitor center at the Mt. Rushmore National Memorial in South Dakota. These solar collectors, shown in the photo against a background of Gutzon Borglum's noted sculptures, are designed to provide the 674-square-meter center with heat and air conditioning. The South Dakota School of Mines and Technology at Rapid City helped purchase the system and will maintain and operate it. It's being monitored for quality of design and construction by NASA's Marshall Space Flight Center for the Energy Research and Development Administration's (ERDA's) commercial solar energy demonstration program. The Mt. Rushmore installation is one of 32 such cost-sharing projects selected by ERDA and managed by the Marshall Space Flight Center.



Hot shot

In our October '75 issue, I wrote about our nation's plan to develop a solar thermal plant capable of generating electricity ("Solar Power Tower"). It would use many sun-tracking mirrors—heliostats—to concentrate sunlight on a single point, producing high enough temperatures in a boiler to yield superheated steam to drive a turbogenerator. Last month, in What's News, you read about the first tests, in which 1775 mirror facets were focused on a quarter-inch steel plate, producing temperatures of 3000° F—enough to burn a two-by-three-foot hole in the target. Now we have photographs of that demonstration of solar power.

The top photo, above, shows the test setup at the ERDA Solar Thermal Test Facility at Albuquerque, N.M. The photo below shows the hole. The facility will be used initially to test boilers atop the tower using some 300 heliostats to produce high-pressure steam at about 1000° F. Average, continuous output under full sunlight should be about five megawatts thermal, enough to generate about 1.5 megawatts of electricity (although no turbogenerator will actually be connected). Eventually, ERDA will build a 10-megawatt electric solar thermal plant near Barstow, Calif.

Continued

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Sportsmen Tips

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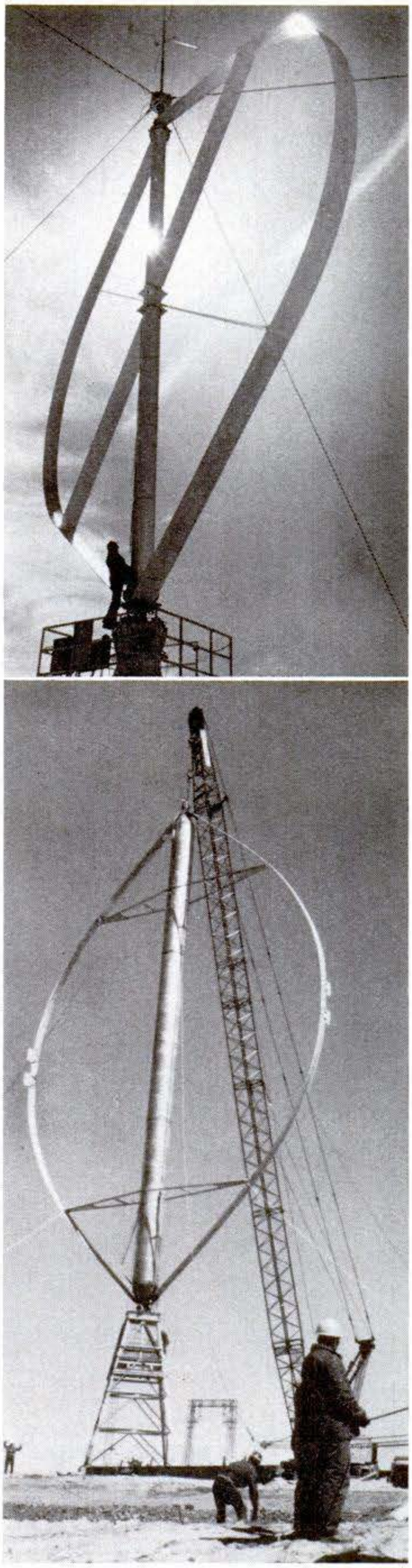
Science newsfront

[*Continued*]



More Darrieus wind turbines

Remember the Sandia Laboratories' "eggbeater windmill" we covered in May '75? The folks at Sandia have now produced a seven-story-high big brother (top photo, above). With 21-inch-wide blades, the new turbine is designed to generate 60 kilowatts of electricity in a 28-mph wind and 30 kilowatts in a 22-mph wind. It's now being tested as part of ERDA's wind-energy program.

Interest in the vertical-axis wind turbine (VAWT) is lively because, although the design extracts somewhat less energy from the wind than conventional horizontal-axis turbines, it may prove to be easier and cheaper to build and run. The reasons: Generating equipment can be attached to the drive shaft at ground level, reducing tower-construction costs (the new Sandia VAWT has a 15-foot-high base housing a transmission and an electrical generator that convert the sun-derived mechanical energy of wind into 60-cycle AC). Moreover, no system is needed to turn the whole mill into the wind, nor is a pitch-control device needed to feather the blades in high winds, because a VAWT under load will automatically stall at high wind speeds.

As a further expression of interest in VAWT's (see the bottom photo), a giant aluminum 160-foot-high turbine is being erected at Hydro Quebec's Institute of Research test facility on Magdalene Island in the Gulf of St. Lawrence. The wind turbine was designed and fabricated by Dominion Aluminum Fabricating, Ltd., in conjunction with Canada's National Research Council. It will operate at wind speeds between eight and 65 mph, can withstand gales up to 100 mph, and should generate 200 kilowatts of electricity, enough to light some 600 homes.

What! Another energy book?

One of our contributors, Norman Metzger [New Coal Technology—the Cinderella Fuel Comes out of the Cellar," March '74], has written a useful new book called *Energy: the Continuing Crisis* (published by Thomas Y. Crowell, New York, for $12.95). It's a meticulously detailed survey of the whole energy spectrum, with a healthy skepticism that is alarmingly lacking in many other such books. By and large, this skepticism is applied with an even hand, smiting both the defenders and the attackers of one scheme or another. At any rate, Mr. Metzger, who has worked for both the American Association for the Advancement of Science and the National Academy of Science, will give you lots of ammunition for those inevitable debates and discussions about our energy programs.

I'm a centenarian

As I was searching for a short item to end with, it occurred to me that this column might have some special, private significance. I checked, and it does indeed: This is the one-hundredth consecutive Science Newsfront I've written for *Popular Science.* But who's counting? PS

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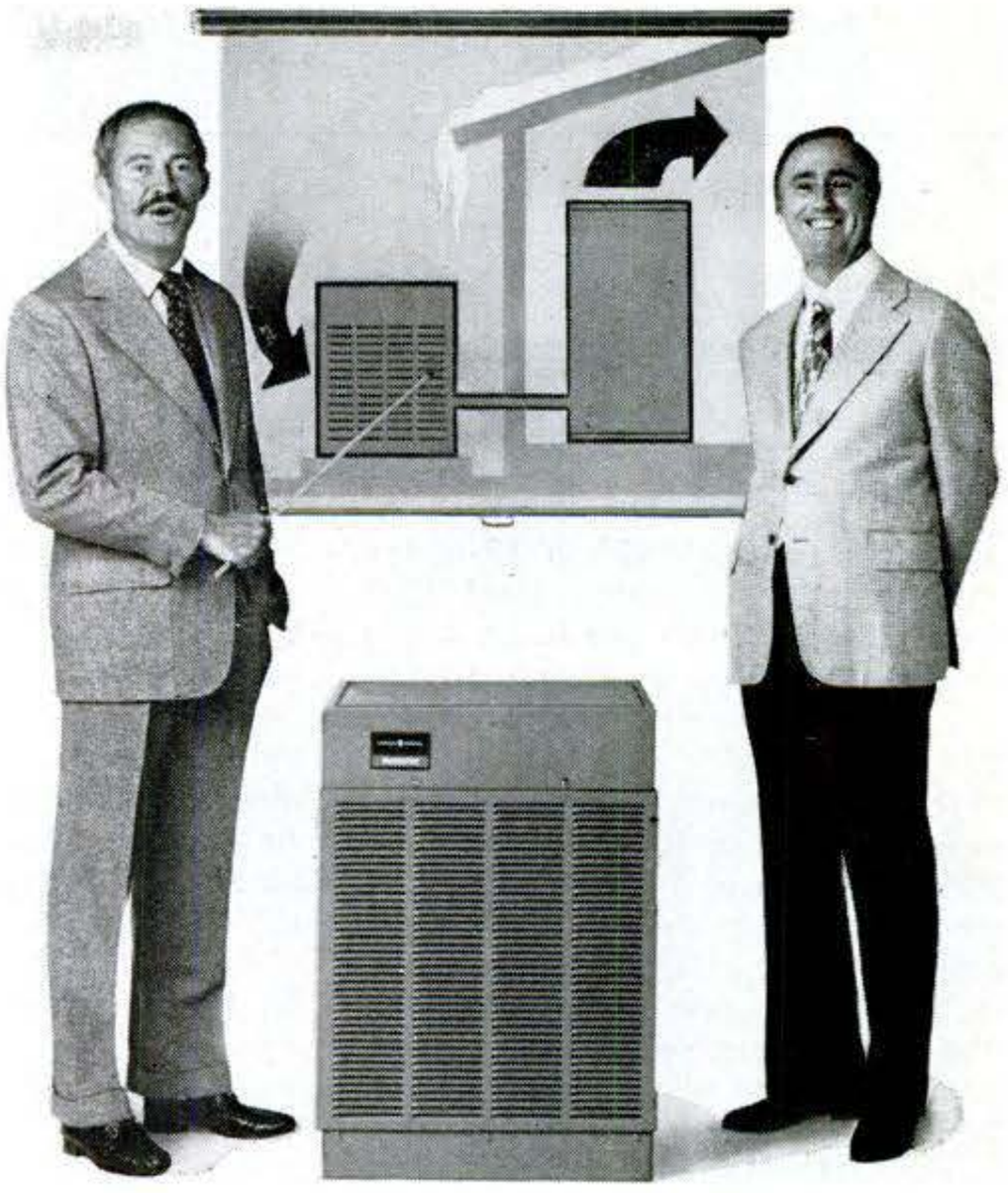
Rowan and Martin explain how the GE Weathertron® Heat Pump can cut your bill for ordinary electric heat 30-60%.*

1. Dan: The General Electric Weathertron heats your home in the winter, cools it in the summer.
Dick: Like a furnace and an air conditioner in one.



2. Dan: Even on cold days, there's heat in the outside air. The Weathertron extracts this heat and pumps it into the house.
Very often, that's all it takes to heat a house.
Dick: And no gas or oil shortage to worry about.

3. Dan: Then in the summer, it works in reverse—it's an air conditioner—pumps heat from inside the house to the outside.
Dick: Keeps you comfortable all year round.

4. Dan: *Saves you 30-60% on your heating bill—compared to ordinary electric heating, depending on where you live.
Dick: Makes perfect sense to me.

For more information, write to General Electric; Appliance Park, Bldg. 6, Room 220, Louisville, Ky. 40225.

GENERAL ELECTRIC

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ON TARGET

By PAUL WAHL

Answers to your questions about steel shot

If you hunt waterfowl with a 12-gauge gun, you may be shooting steel shot loads this season. There are some things that you should know about steel shot, though, and its federally mandated use —before you use it.

For many years, wildlife-management people have been concerned about lead poisoning in ducks and geese, caused by ingesting spent lead shot while feeding. In 1959, biologist Frank Bellrose of the Illinois Natural History Survey estimated that the annual nationwide lead poisoning loss amounts to two to three percent of the autumn waterfowl population, which averages 100 million, according to the U.S. Fish and Wildlife Service. The overall mortality rate is put at 50 percent, with hunting accounting for 20 percent and other causes (starvation, disease, predation, accident, etc.) 30 percent. Of course, the prime factor limiting waterfowl population is habitat.

Since FWS still accepts Bellrose's estimate as a reasonable assessment of the magnitude of lead poisoning, it may be assumed that the problem has not worsened in almost 20 years. It is interesting to note that, in 1959, Bellrose concluded that lead poisoning in waterfowl was not of sufficient importance to warrant a conversion to nontoxic shot.

With the intent of reducing the number of waterfowl deaths caused by lead poisoning, FWS decided in 1976, after much controversy, to implement progressively a rule requiring the use of steel shot in designated areas. Soft steel shot is the best available nontoxic substitute for lead in shotgun pellets.

During the 1976-77 season, this lead-shot ban applied only to parts of nine Atlantic Flyway states. For 1977-78, it has been extended to specified zones in 13 of 17 Atlantic Flyway states and 11 of 13 Mississippi Flyway states. Next year, certain sections of the Central and Pacific Flyways will be added and areas already subject to the law will also be expanded.

Since steel shot loads are now available only in 12 gauge (used by about 85 percent of hunters), a temporary exemption has been given users of 10-, 16-, 20-, 28-, and 410-gauge guns, who may hunt waterfowl with lead shot loads in steel shot zones. The ineffective 28 and 410 gauges are not suitable for duck and goose shooting—and should be illegal for such kinds of shooting.

The current choice of 12-gauge steel shot loads is rather limited, although both Federal and Remington are expected to add 3-in. magnums in the near future. Available steel shot loads, all high-velocity, now include: Federal 2¾-in. shell with 1⅛-oz. No. 1, 2, or 4 shot; Remington 2¾-in. shell with 1⅛-oz. No. 1 or 4 shot; Winchester 2¾-in. shell with 1¼-oz. No. 1, 2, or 4 shot; Winchester three-in. magnum shell with 1½-oz. No. 1, 2, or 4 shot. Federal and Remington shells are priced at $9.05 per box of 25, while the Winchester loads cost $9.60 and $12.30 respectively. These prices are as much as 40 percent higher than those of comparable lead shot shells.

Hand-loading would be a way to beat the high cost of factory-made steel shot shells, but unfortunately neither loading data nor the necessary components—soft steel shot, special shot cups, wads, and powders—are as yet available. Do not substitute steel shot for lead in factory-loaded shells or prepare hand loads using steel shot with the other components and data for lead shot loads. To do so risks a barrel burst. Specially designed for the purpose, steel shot for shotgun shells is considerably softer than common steel pellets such as air rifle BB's, peening shot, and ball bearings, which can ruin a shotgun barrel in one firing.

How do steel and lead shot loads compare in killing efficiency? A review of government, industry, and independent test results indicates that the two shot loads are roughly comparable in effectiveness at ranges up to 40-45 yards. Beyond that limit, lead shot performs significantly better. Because steel shot patterns are very tight, the shooter's margin for error is reduced. Remington has recommended that hunters using steel shot wait for birds that come within 40-yard range. Federal advises: "Because steel shot pellets weigh less than lead pellets of the same size, they have less long-range hitting power than lead. So hunters should use larger sizes of shot when switching to steel. If you normally use No. 6's in lead, use No. 4 in steel. If you prefer No. 4 lead, use No. 2 steel. Size No. 1 steel shot is a good bet for goose hunters."

Crippling losses are expected to increase with widespread use of steel shot, reducing its net effect in saving waterfowl. Opponents of the lead shot ban see an increase of 2½ to three million birds downed but not retrieved annually, while FWS estimates it will be less than 377,000.

Gun damage from steel shot is a real problem and a major concern of shooters. On the back of a box of Remington Steel Shot Duck Loads is this notice: "Remington cannot accept responsibility for barrel damage resulting from the use of steel shot." Federal and Winchester boxes carry similar disclaimers of liability. Every new Savage shotgun bears a tag that tells the consumer: ". . . any injury, damage, wear, or consequences from the use of steel shot in this shotgun are at the user's risk."

Recently, the Winchester-Western Division of Olin Corp., which has conducted extensive tests with steel shot, advised: "The use of shotshell loads containing soft steel shot—hardness not to exceed 90 DPH (diamond-point-hardness)—in most shotguns will eventually result in barrel damage through expansion, or forcing out, of the choke. This damage usually takes the form of a ring on the outside of the barrel near the muzzle. Damage will vary from gun to gun, depending on the type of steel used in the barrels, the type of choke, and the number of steel shotshells fired. Such damage may or may not be visible to the naked eye, and has little effect on pattern performance or the useful life of modern, high-quality slide-action and semiautomatic shotguns . . . We recommend that steel shotshell loads *not* be used in high-quality, expensive side-by-side or over/under double-barreled shotguns, or in lightweight thin-walled doubles and tightly choked shotguns of foreign manufacture."

Typically, the ring—caused by the peening effect of steel shot on the choke area—appears as a slight bulge about 0.005 in. above the plane of the barrel, 1½ to 3 in. from the muzzle. This choke expansion, which becomes discernible in some guns after firing 100-500 rounds of steel shot, generally stabilizes at this size and does not become measurably larger with the firing of several thousand more shots. There is no known hazard to the shooter from such damage and, from a practical standpoint, it may be only cosmetic. But a ringed or bulged barrel does depreciate a gun. A replacement barrel for a pump or autoloader costs upwards of about $50.

Before you use steel shot loads in your gun, get the advice of its manufacturer or importer.

A book on bird dogs

More than the title suggests, *The Complete Guide to Bird Dog Training* by John R. Falk helps the reader in selecting the breed best suited to his kind of hunting and gives valuable advice on buying, as well as detailed step-by-step training procedures. If there's a bird dog in your future, be sure to get this excellent book: 247 pages, illustrated, $10. From Winchester Press, 205 E. 42nd St., N.Y., N.Y. 10017. PS

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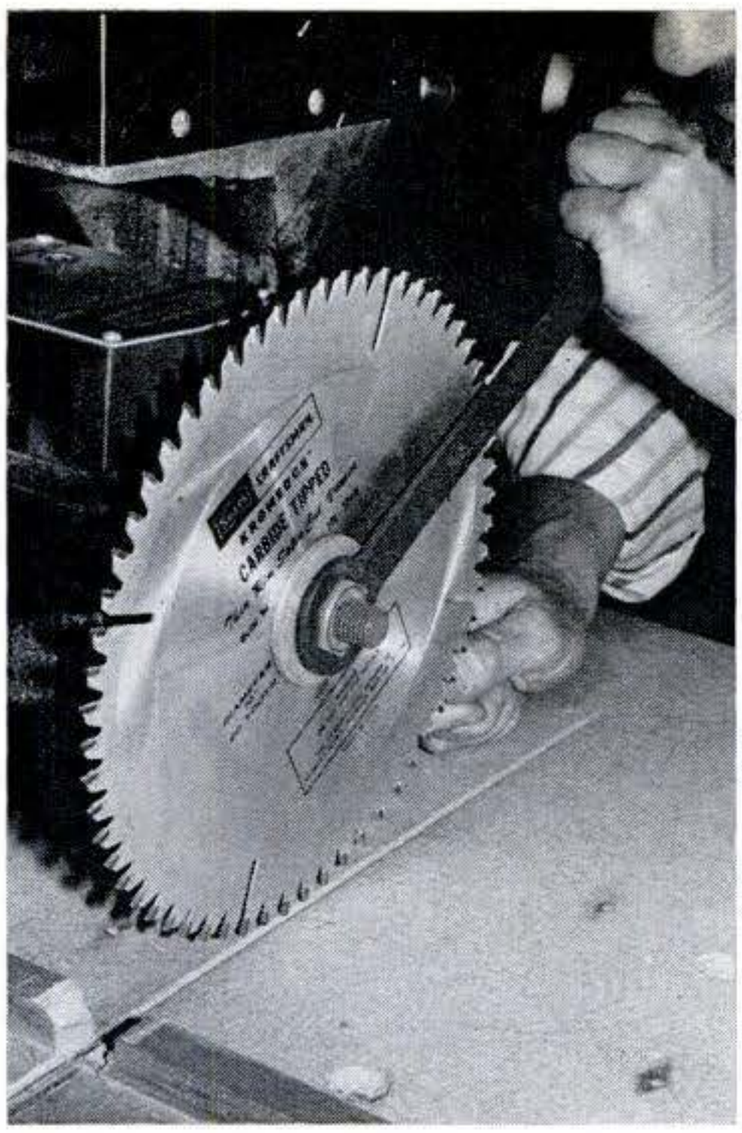
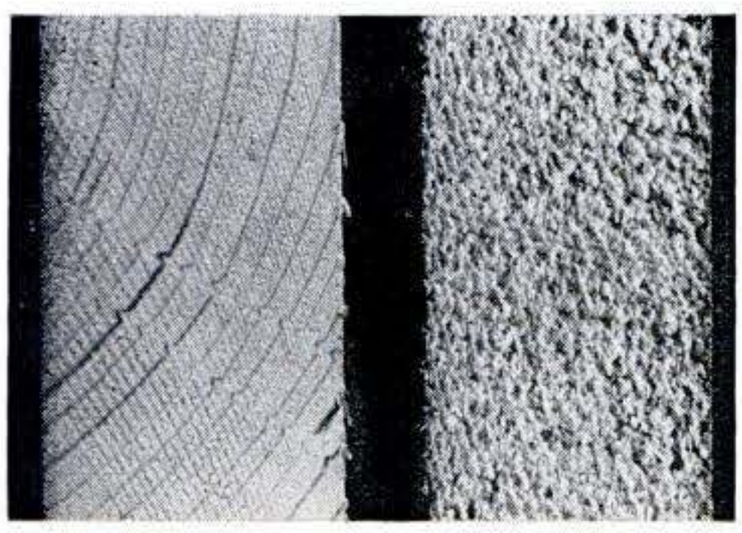


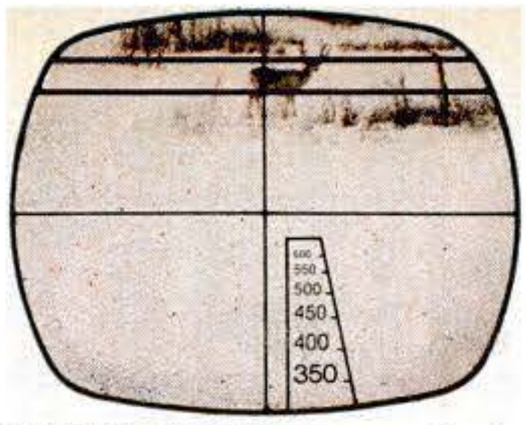
Silky-smooth-cutting carbide blade

I've been using a satin-cut veneer blade for most work on my radial-arm saw for years because I like that smooth cut. For that, I'm willing to put up with the slow cutting. But now I don't have to. I recently tried the new Craftsman carbide blade that has 60 alternately beveled tips. Now I get smooth cuts *and* high-speed cutting with the same blade.

The pictures at the bottom of this page tell the story. On the right is a piece of soft pine I cut with a newly sharpened combination blade. Next to it is a slice of the same board I took with the carbide blade. In all honesty, the carbide doesn't produce a cut with quite the sheen of the veneer blade. In this slightly magnified view (that's a ¾" board), you can see the tooth marks. But the difference is slight, and the cutting is three or four times faster with the carbide blade.

Carbide blades still aren't cheap, but they've come down. The 60-tip 10" version (catalog # 9 GT 32428) now sells for $39.99. And it should go five times as long between sharpenings.—*C. P. Gilmore*





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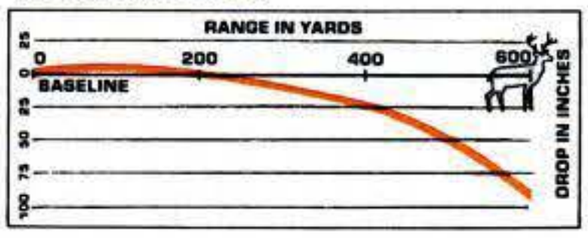

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In our power supply, instead of finding a conventional transformer, you'll find a heavier, more advanced toroidal-core transformer. It's less susceptible to voltage fluctuations. And less likely to leak noise. Which means you get a cleaner, clearer sound. And instead of finding the usual two electrolytic capacitors in the power supply, you'll find four. Because we've found that the two extra capacitors help improve low frequency response. And protect against tone burst distortion.

An extraordinary power supply, for an extraordinary amount of power.

*160 watts per channel minimum RMS continuous power output at 8 ohms, from 20 to 20,000 Hz with no more than 0.1% total harmonic distortion.

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THE SX1250.

THE FM SECTION: A FIVE GANG VARIABLE CAPACITOR.

The average high powered (and low powered) receiver comes with a three, or four gang variable capacitor for FM tuning. Not the SX 1250. It comes with a *five* gang zinc plated variable capacitor that cleans up FM reception much better. And helps to pull in stations that some three or four gang capacitors can't even touch.

A five gang variable capacitor for FM reception that never varies.

OTHER POWERFUL ARGUMENTS FOR THE SX1250.

Our pre-amp circuit was designed with the unheard-of phono overload level of 500 millivolts. Which means that no magnetic cartridge in the world can make it distort.

It was also designed to follow the RIAA curve (the recording standard of the record industry) to within 0.2 decibels. So you not only hear everything that was recorded, but you hear it *exactly* the way it was recorded.

And where some high powered receivers give you two or three tone controls, the SX 1250 gives you four. They're calibrated in 2 decibel click stops; which give you 3,024 ways to make the most out of your music.

Given all this, it should come as no surprise that the SX 1250 even outweighs most of our competition.

So before you buy just any high powered receiver, consider everything that went into the SX 1250. And weigh your decision carefully.

High Fidelity Components

PIONEER®

WE BRING IT BACK ALIVE.

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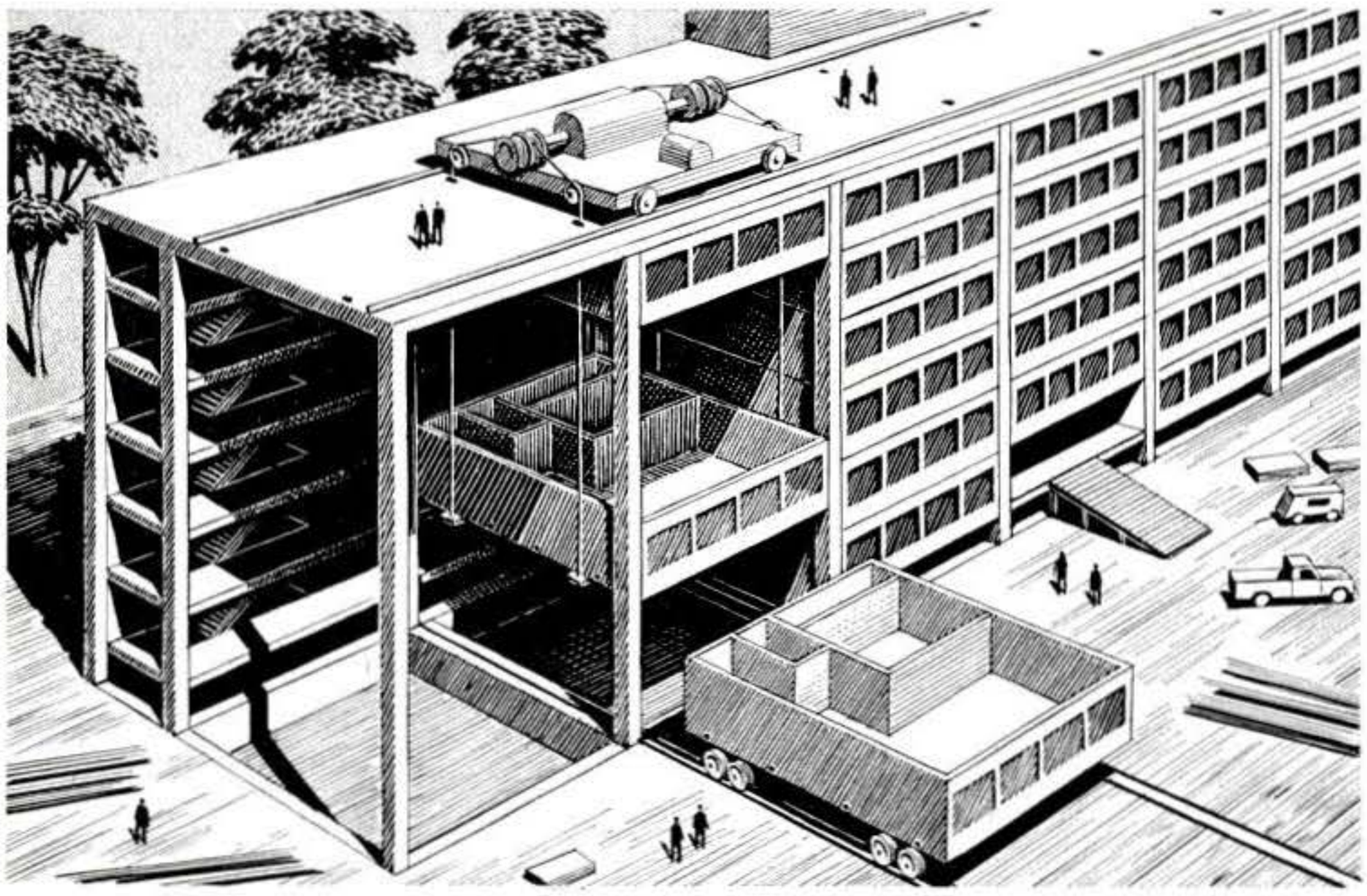
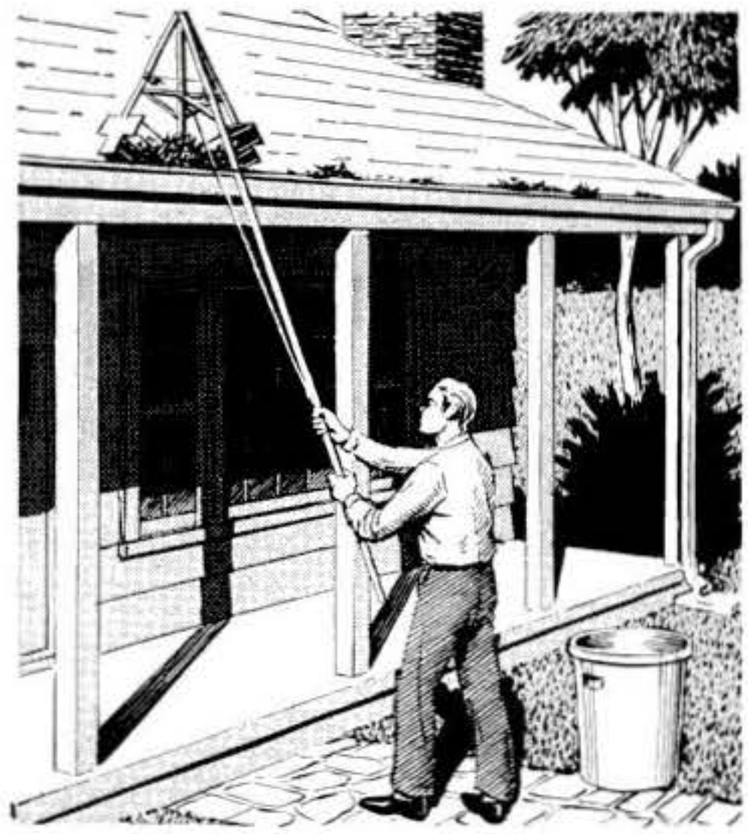
NEW IDEAS FROM THE INVENTORS

ILLUSTRATIONS BY RAY PIOCH



Prefab floor modules lift into housing shells

High-rise and multistoried buildings might rise faster and at lower cost with this system for stacking prefabricated housing units within structural frames. Load-bearing vertical posts erected on site would be topped by a tracked platform for a movable winch. Prefab units rolled into the open shaft space would be lifted, top floor first, into final position and locked to the supports. Post-carried piping and wiring could then be coupled to the prefabs.



Remote compactor cleans gutter

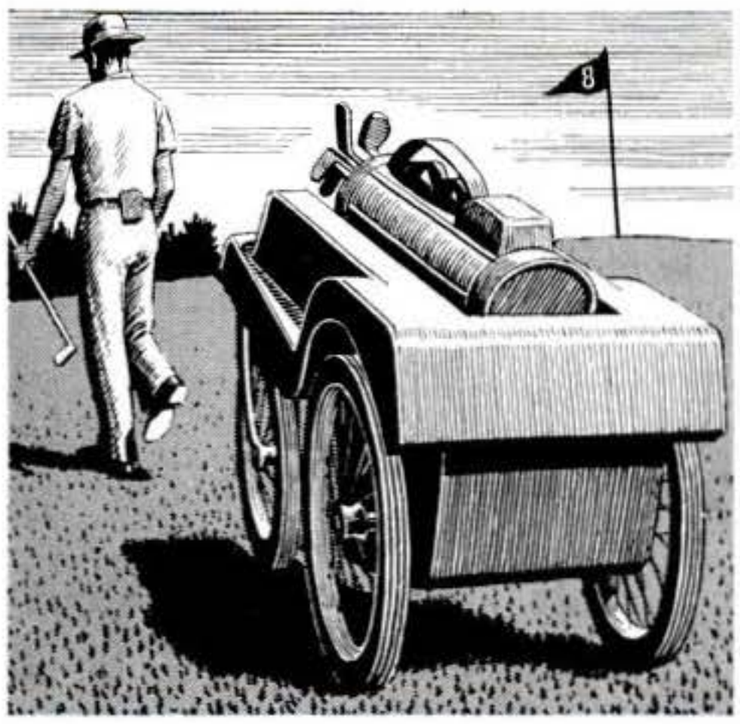
Held apart by springs, two tine-tipped downward-reaching jaws on this gutter cleaner would be drawn together by a pulleyed cord at the other end of a pole. While standing on the ground, you could scrape leaves and other debris into compact wads and lift them out of a gutter. The cleaner would speed the work, eliminate climbing hazards, reduce ladder damage to flowerbeds.

Door panel forms flood barrier

U-shaped channels fastened and caulked around door frames and other ground-level building openings might help to reduce water damage to houses in flood-prone areas. When flooding occurs—or seems likely—a panel could be slipped into the channels. It would keep out water and mud without interfering with movement in and out of the house.

Purse strap sounds alarm

A purse snatcher might think twice about fighting a woman for her pocketbook if his first grab set off a compact buzzer alarm built into the bag. The battery- (or spring-) powered buzzer would be triggered by a switch connected to an elastic strap with a wrist loop at one end. The strap would have enough stretch to prevent accidental triggering.



Radio cart follows golfer

A sensitive directional antenna on this battery-powered golf cart would interpret signals from a transmitter carried by a golfer. Changes in signal strength would adjust wheel speeds to the golfer's pace to maintain a constant distance. Separate wheel circuits would speed the left or right wheel, like a differential, to follow around turns.

The following patents have been issued on these inventions: **Building hoist**—No. 3,863,418 to Pierre Faucheux, Paris, France; **Flood-barrier panel**—No. 3,861,081 to Stanley J. Maskell, Phoenix, Ariz.; **Purse alarm**—No. 3,815,118 to Lester E. McDonald, Downey, Calif.; **Gutter cleaner**—No. 3,972,552 to James W. Earp, Jr., Raleigh, N.C.; **Radio-directed cart**—No. 3,812,929 to Claude Anthony Farque, Fayetteville, Arkansas.

Copies of patents may be ordered, by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the Commissioner.

Copyrighted material

Why a small car demands more of an oil than a big car.

Just because small cars are easy on gas, easy to handle and have smaller engines, don't assume they're easy on oil.

The heat in a small engine can drain the life out of an oil.

Smaller cars with their 4- or 6-cylinder engines circulate their oil twice as fast as big sixes or eights. And they run at 25 to 30% higher revs. So there's more friction and heat in the engine.

Then to add insult to injury, they have less engine surface and less room in the engine compartment to get rid of that extra heat.

All this causes increased wear, tear and shear (thinning out) on your oil. Which can keep it from lubricating and cleaning properly.

From there it's only a short step to preignition, power loss and premature engine wear.

To solve this oil crisis, you need Castrol.

Castrol started out in Europe where small cars started out. So naturally it was Castrol that first added the additives a motor oil needs to protect those high-revving engines.

And today's Castrol incorporates the costliest additives available anywhere. That keeps Castrol from thinning out under intense heats and pressures. It keeps sludge from forming as the oil cools down. And it gives Castrol the strength to keep lubricating and cleaning the narrow passages in smaller engines.

Of the best selling oils, only Castrol has passed both U.S. and foreign car engine testing.

Since Castrol is designed to withstand the tortures of small car engines, we make sure it passes the engine tests for foreign cars set by the CCMC* (on a Fiat 124, Ford Cortina and Mercedes-Benz diesel) as well as the engine tests set up by the SAE,** (on a '67 Olds 425 cid V-8 and a Ford 302 cid V-8.)

Then to satisfy ourselves even further, we test Castrol on two additional small car engines: a 1302cc VW and a 1798cc MGB.

So naturally, all grades of Castrol exceed all U.S. and foreign car manufacturers' specifications.

Now if you have a smaller car, you have some big reasons to change your oil.

Castrol

The first oil engineered for smaller cars.

*Organization of European Car Makers, Engineers and Oil Manufacturers.
**Society of Automotive Engineers.

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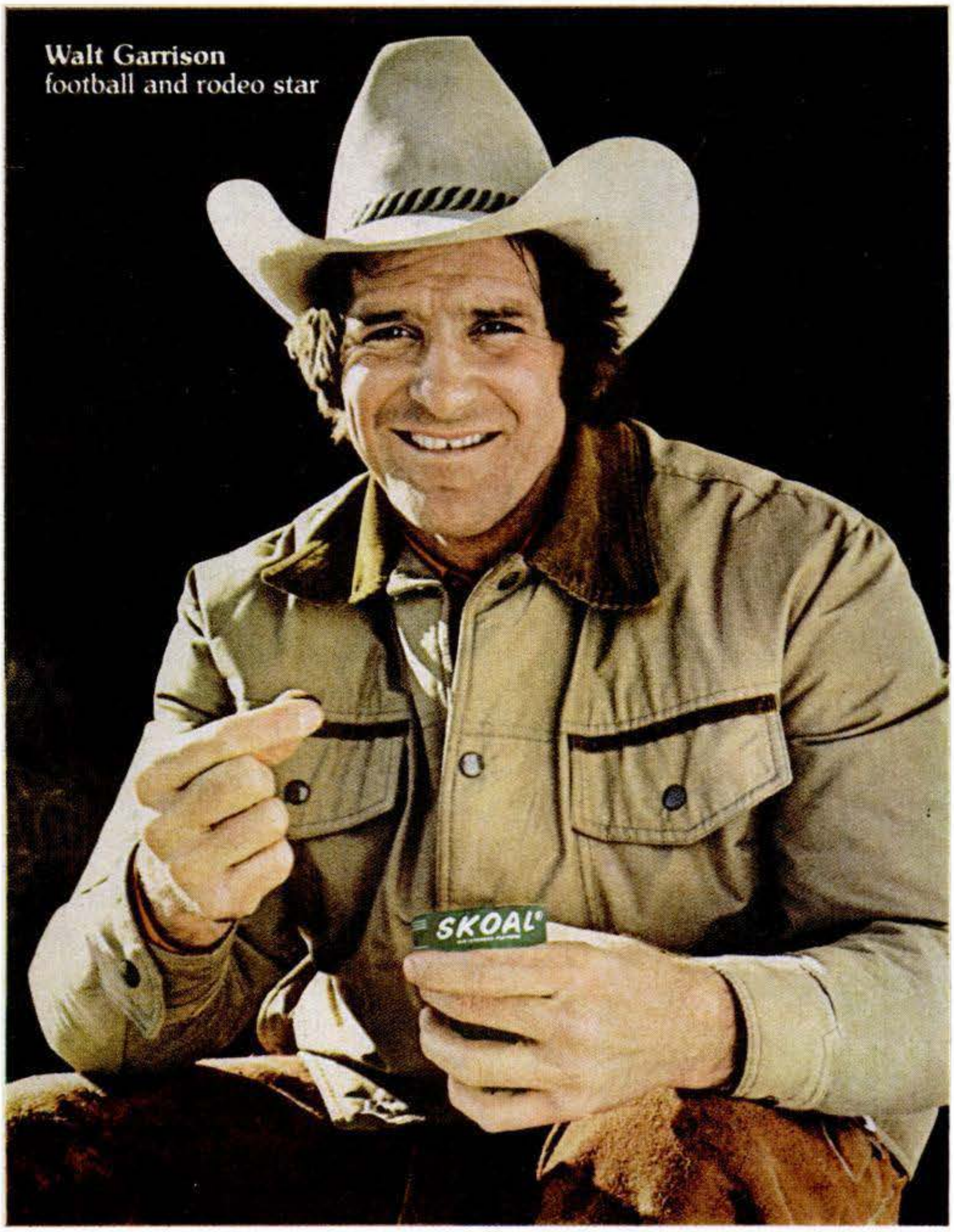


I love tobacco. I don't smoke.

My tobacco pleasure is Smokeless. That means I get full tobacco enjoyment without lighting up, or tying up my hands. And you can too. With Copenhagen for straight tobacco taste. Or with my favorite, Skoal, with the wintergreen flavor. Then, of course, there's mild Happy Days Mint, for you guys that are just beginning. All three are dated for freshness. So just take a pinch and put it in between your cheek and gum. You'll see that going smokeless is a mighty nice way to enjoy tobacco, and mighty relaxing too.

If you can't find any of these fine brands at your local store, or if you're interested in just trying a few free pinches, write to; "Smokeless Tobacco," U.S. Tobacco Company, Dept. PS097, Greenwich, Conn. 06830. We'll tell you where to find "Smokeless Tobacco" in your area. And we'll send you a free sample in the mail.

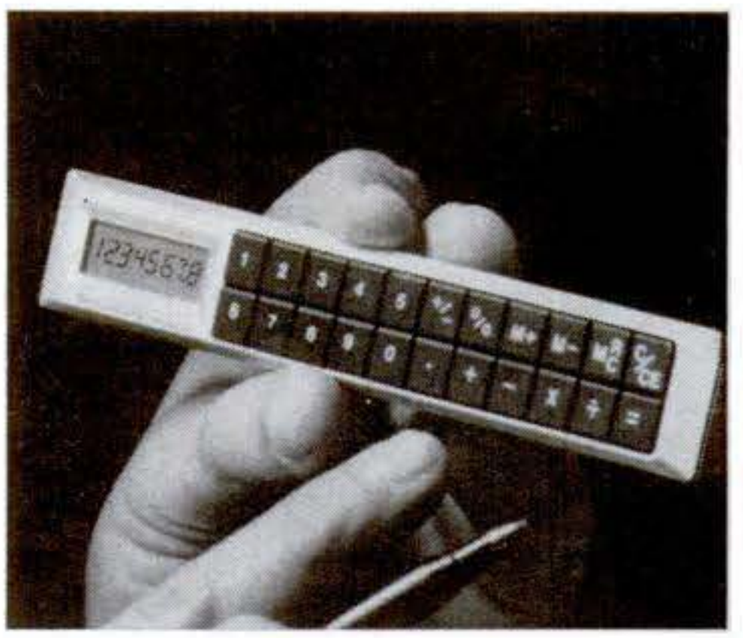
Smokeless tobacco. A pinch is all it takes.

©U.S. Tobacco Company

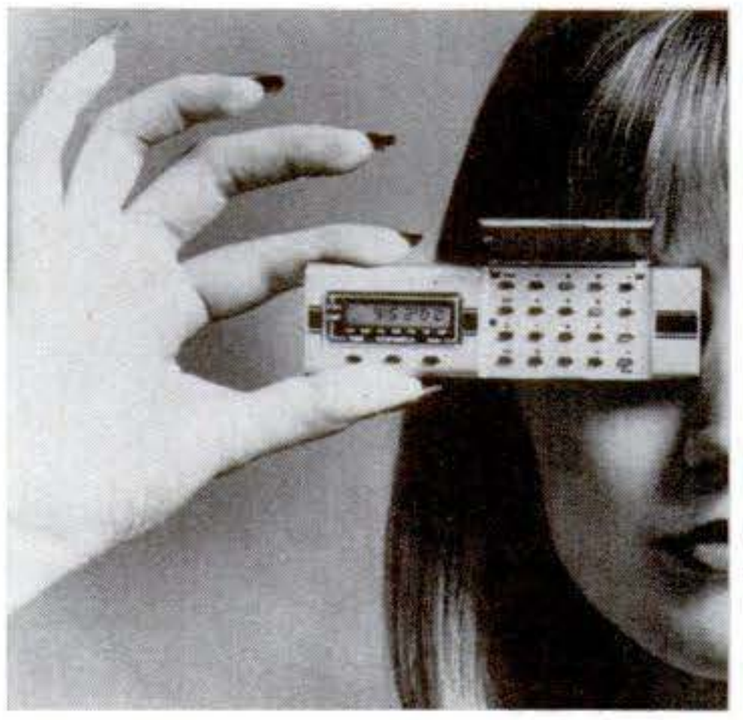
Offer not available to minors.

Clever new take-along **calculators**

Six functions—time, alarm, timer/stopwatch, date/calendar, calculator, and memory—make Hewlett Packard's $650 HP-01 wrist instrument exceptionally versatile. A low-power microprocessor permits interaction between major functions, such as continuously updating and displaying the cost of a phone call. The three-battery HP-01 has 28 keys—six finger-operated, 22 stylus-operated. The 11-digit calculator rounds off to seven digits on the LED display.



Pencil-thin DataClip calculator from Texas Instruments has an eight-digit liquid-crystal display and operates 1000 hours on a set of batteries. The $35 DataClip has five functions.



A four-function calculator is combined with clock, stopwatch, and calendar functions in Casio's $60 MQ-1. The six-digit liquid-crystal display shows two more digits at the touch of a button.

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Pay & Benefits

If you enlist in the Army, you'll start with good pay; a long list of job-training courses to choose from; 30 days paid vacation each year; the opportunities to travel and to continue your education. For more information about all the opportunities in today's Army, send the postcard. Or call 800-431-1976 toll free. In NY call 800-243-5614.

Europe.

"It's an awakening. The experience really opens your mind. Not just because you can see a lot of famous places. Here, you also get a very strong sense of what it is to be a soldier. The work is hard—long weeks in the field, in a climate a lot of us aren't used to. But when you make some friends—like I have some German and French friends—they believe in you. They give you another view of yourself and this job you're doing. I think enlisting in the Army for Europe is a good way to see Europe—and the Army."

SP4 William S. Morgan, 8th Infantry Division, Baumholder, Germany

Join the people who've joined the Army.

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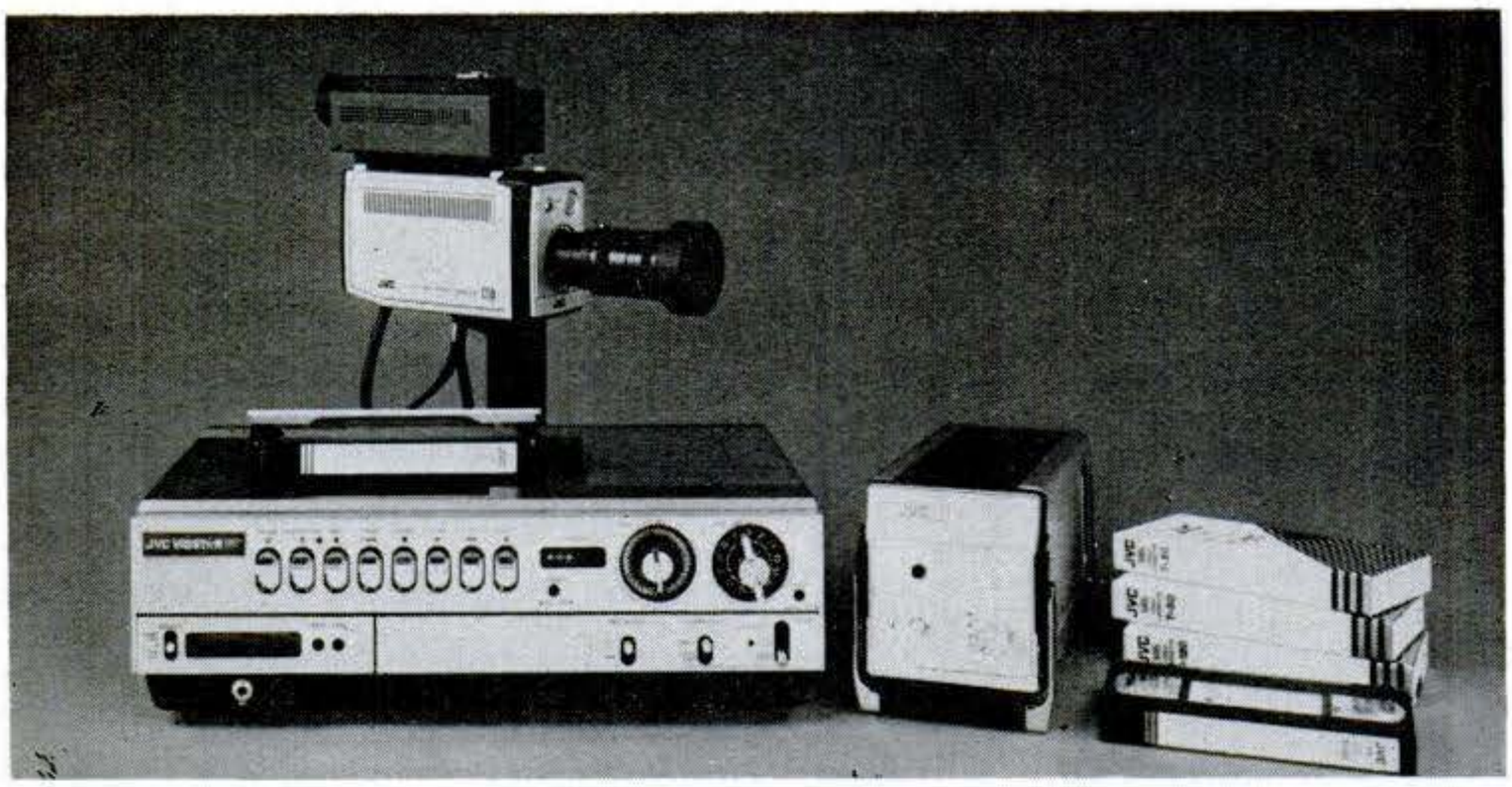
LOOK AND LISTEN

By JOHN FREE



JVC's VCR spectacular

JVC introduced its new Vidstar VHS (Video Home System) in a lavish display at the summer Consumer Electronics Show in Chicago. Options for the video-cassette recorder include the least expensive color-TV camera yet, plus an attachment for transferring movie film or slides onto video tape.

The two-hour VCR is exceptionally compact—smaller, in fact, than some audio-cassette decks. Taped pictures from the camera and a master tape were excellent. The Vidstar deck costs $1280 and a two-hour tape is $20. A basic two-tube camera with color corrector (center, above) is $1500. The electronic viewfinder and zoom lens shown above boost the price to $2150. JVC's Telecine prism/lens attachment, for transferring film to tape through the camera, is less than $100.

Magnavox and GTE Sylvania, meanwhile, have announced they'll market the two-speed version of VHS. This deck, capable of four-hour recordings, was developed by JVC and its parent firm, Matsushita. Others offering the four-hour machine are: RCA, Sharp, Mitsubishi (MGA), Hitachi, and Panasonic, one of Matsushita's U.S. subsidiaries. In the two-hour mode, there's compatibility among all these VHS machines.

A dark-horse entry in the accelerating home-VCR race may come from Germany's BASF, the originators of magnetic tape. BASF, with cooperating U.S. firms, is developing a two-hour longitudinal video recorder (LVR), with marketing possible this year.

LVR reportedly uses quarter-inch tape instead of the usual half-inch width. Also, its video head is stationary, while the cassette tape whizzes back and forth at 120 i.p.s. By contrast, tape in a VHS deck (four-hour mode) moves at only 0.66 i.p.s., but two video heads spin at high speed. BASF and other home-VCR manufacturers are planning to introduce portable recorders for each cassette format, too.

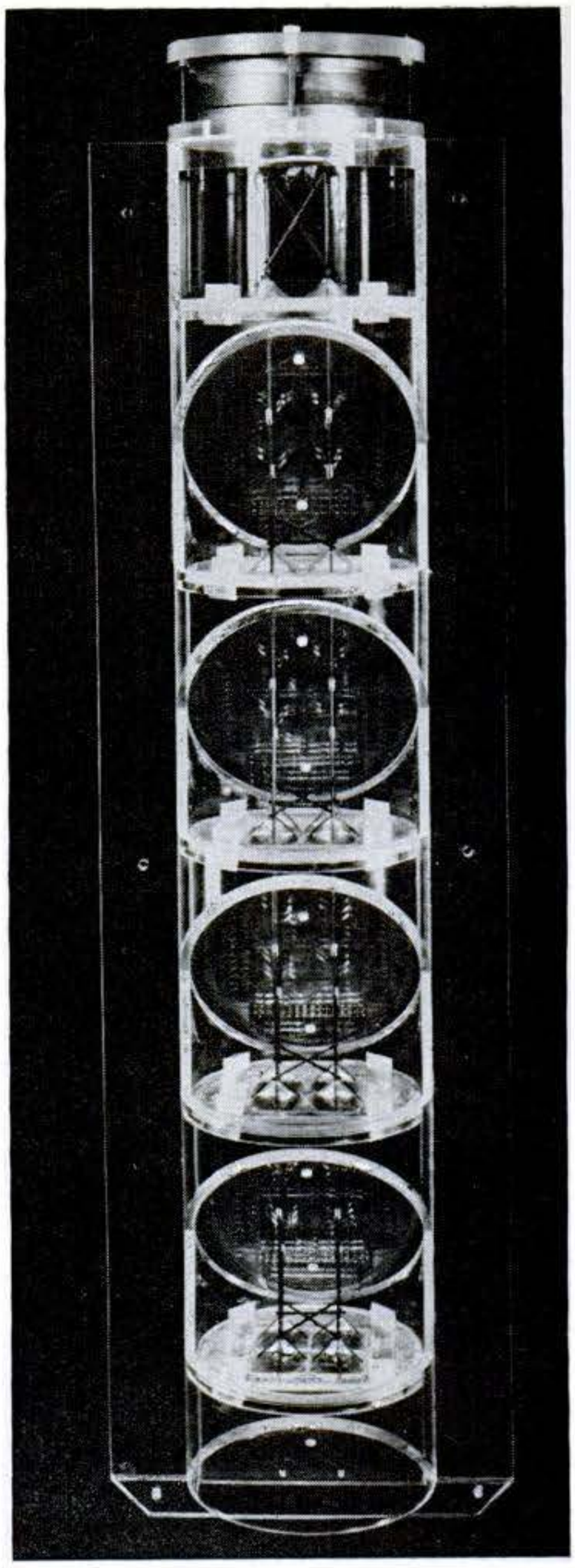
Projection TV brightens

Panasonic and others privately demonstrated a super-bright projection TV to dealers at CES. The system may be available next year. Sony half-heartedly entered the projection-TV field some time ago [L&L, Aug. '75], but new models from Japan could stimulate competition from other set makers and trim high prices.

Panasonic's single-piece model has a five-foot screen with an extra-bright image that's viewable in a well-lighted room. The trade weekly *Television Digest* reports that next year Panasonic may offer a model with a VCR included for about $3000.

Mitsubishi also demonstrated a two-piece system to dealers. The projector has three separate tubes, similar to Advent's models [see What's New in Electronics, this month]. The seven-foot screen displays a bright 30-35-foot lambert image.

While I didn't see the Japanese models, I did examine another extra-bright, single-piece projection TV that ESS is developing with Tinsley Laboratories. ESS's 40-foot L image is much brighter than other single-piece sets being sold, and pictures held up well with sunlight streaming into the McCormick Inn demo room. The image is projected onto the rear of a translucent 52-inch screen covered with thousands of tiny lenses. An elaborate optical system—curved mirror,



28-inch lens, front-surface mirror, and flat Fresnel lens—projects images from a small-screen color set. The price may be $2200 to $4000, depending on options.

Audio-video briefs

- Winner of the CES design and engineering award was ESS's Transar/atd, a speaker system combining an unusual new Heil low-frequency driver (above) with Dr. Oskar Heil's high-frequency air-motion transformer. Transar's low-frequency section was shown in its final developmental stage; its long-available high-frequency section is described elsewhere in this issue. The low-frequency driver in the $2000 Transar has five vertically stacked Lexan diaphragms connected by four carbon-fiber [PS, April '75] rods, all driven by one voice coil. The stiff drive rods propagate sonic information almost instantaneously to produce awesome bass.
- Also seen at CES:

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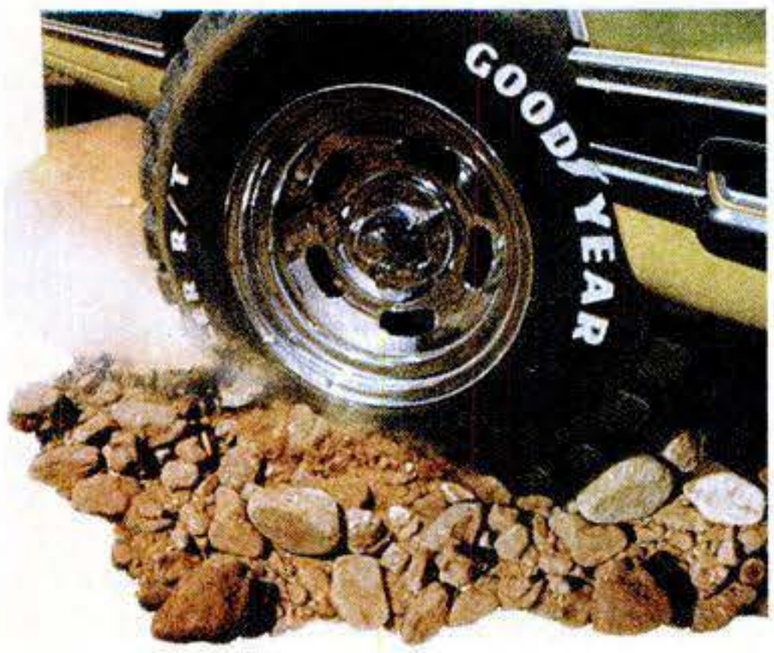
When the trail isn't there, Goodyear Wrangler R/T tires should be.



A tire has to do a lot of performing to get through terrain like this. Mostly, it has to keep a lot of rubber on the ground. And that's where the Wrangler R/T is in a class by itself.

The Wrangler R/T has "straight up and down design," so it has a wider footprint than any other tire in its size ranges. That makes for a lot of traction, whether you're going through mud, snow or soft sand.

Add to that a strong, yet smooth-riding, polyester cord body, long-wearing tread compounds, fiberglass cord belts, a center riding rib for smooth highway performance, and you get the kind of tire you can really depend on.

Those are just some of the reasons why more roads and trails get blazed on Goodyear's full line of tires than any other kind. And why Wrangler R/T's took first place in the 1977 Mint 400, the most brutal desert race in North America, in both the stock production four-wheel-drive class and the stock production pickup class.

The Goodyear Wrangler R/T.

It's the tire to have if you don't have a trail. Or if you do.

The more you see, the more you get. You see more with a Weaver Wider-View.

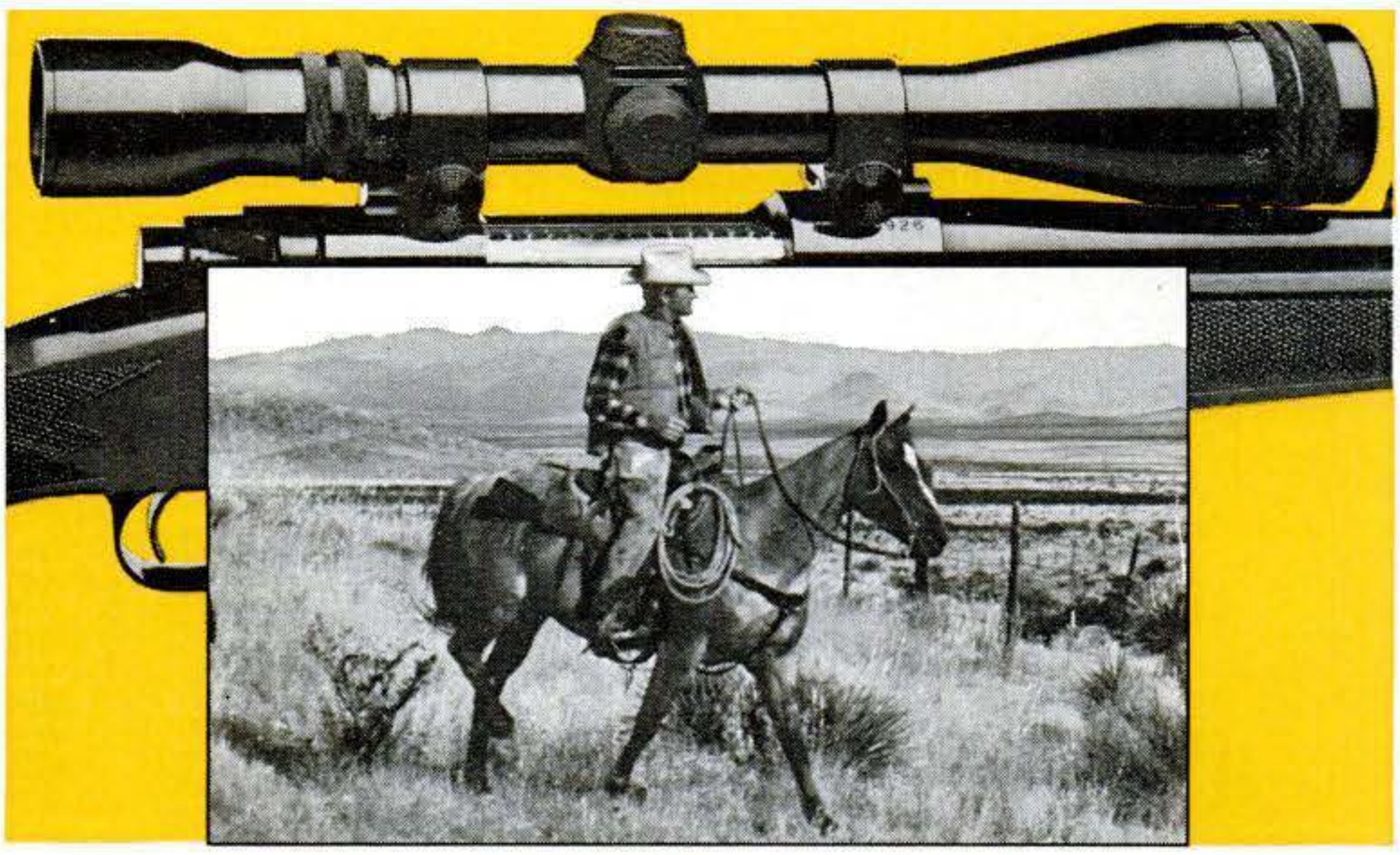
As much as 40% more.* So you see that big trophy standing to one side of the smaller one. You can lead that fast-moving varmint. You can see more, whether you're in the open or in woods.

You get a tough, dependable hunting scope. One-piece steel tube. Precision-ground optics. Accurate adjustments. Weatherproof sealing. All assured by individual testing of every scope.

See all six Weaver Wider-Views at your dealer. Or write for free 1977 catalog showing all Weaver scopes, sights, mounts. W. R. Weaver Company, Dept. 102, El Paso, Texas 79915.

*on Model K3-W; percentage increase varies by model and power.

WEAVER SCOPES
The Great American Scope.



How to get rich

START YOUR OWN BUSINESS RIGHT NOW FROM YOUR HOME—AND MAKE A FORTUNE IN MAIL ORDER!

Mail Order Beginners Get Cash by Mail!

Have you ever thought of operating a little mail order business of your own? Something you could start on a shoestring right from home in your spare time. It's a fabulous business!

Bob Carter of Newark, N.J. ran his first small mail order ad in House Beautiful magazine—offering an auto clothes rack. Business Week reported that his ad brought in $5,000 in orders. By the end of his first year in Mail Order, he had grossed over $100,000!

Another beginner—a lawyer from the midwest, sold a mail order item to fishermen. Specialty Salesman magazine reveals, "he made $70,000 the first three months!"

There is no other business where you can make a fortune so fast. Come up with a 'hot' new item . . . and WHAM!

It strikes like a bolt of lightning!

Millions of people read your ad and suddenly, you are swamped with cash orders from all over the country . . . MORE MONEY in 60 days than you could earn in a lifetime!

Like the Vermont dealer who ran one ad in Sports Afield magazine. His ad pulled 22,000 orders—over A HALF MILLION DOLLARS IN CASH!

Yes, Mail Order is the fastest-growing, most profitable business in America! And now with the population explosion . . . the huge teenage market . . . and more people moving to the suburbs—we are on the verge of the BIGGEST BOOM in Mail Order history!

Free

If you are sincerely interested in starting a lucrative business of your own ACT NOW! We can help you get rich in Mail Order just as we've helped others. Mail the coupon or send a postcard. We'll send you a free book, catalog, ads and complete facts about our offer. No salesman will call. No obligation. You don't need previous experience but you must be over 21. Write to:
Mail Order Associates, Inc., Dept. 439
Montvale, New Jersey 07645

Mail Order Associates, Inc., Dept. 439
Montvale, New Jersey 07645
Please rush full details immediately.

*Name*_____
*Address*_____
*City*_____
*State*_____ *Zip*_____

Look and listen

[*Continued*]

BSR unveiled a multiplay version of its amazing Accutrac 4000 turntable [L&L, July, '76]. The new Accutrac +6 ($300 and up) lets you play six albums, listening to tracks on each disc in any sequence. A microcomputer memorizes the desired sequence, while an infrared sensor in the cartridge head helps count tracks. Instead of dropping discs on each other, the +6 lifts completed discs and slows down platter spin to avoid friction between discs. All operations can be performed with an optional calculator-like sonic remote control.

Sony showed an experimental turntable that lets you flip over a record or start and stop play with a wired remote control. And Infinity System premiered the $400 Black Widow Turntable that has a platter floating on a column of air.

● In Japan, Pioneer Electronics Corp. will make industrial video-disc players in an arrangement with MCA Inc., the entertainment conglomerate that is also turning out discs for the Magnavox-produced Philips-MCA home player [PS, Feb.] slated for test-marketing this year. Before 1980, Pioneer may also make a $500 home video-disc player compatible with the Philips-MCA machine. MCA has been assembling industrial players expensively by hand for government agencies like the CIA.

● A new tape head for audio and video recorders developed by Hitachi uses a Hall-effect semiconductor element instead of a conventional coil. Unlike coil-type heads, the Hall element is not dependent on the rate of change of magnetism in the tape passing over it (a 400-Hz signal doesn't produce twice the output of a 200-Hz signal). Conventional playback equalization, which compensates for increasing output at higher frequencies, isn't required. Other advantages are better low-frequency sensitivity and less phase distortion.

● Ever think your window panes would make good hi-fi speaker tweeters? A Huntington Beach, California, firm, Barcus-Berry, Inc., discovered that by attaching an energizer to a five-by-seven-inch sheet of plate glass, it created a hi-fi supertweeter that can reproduce even ultrasonic frequencies. The company plans to market a $300 speaker with a glass tweeter and conventional woofer.

● A new batch of programmable video games appeared at CES, with many models approaching the sophistication of costly commercial arcade games. Bally and others introduced models with sound and color. Bally's $299 Professional Arcade includes a four-function calculator that "prints out" problems on your TV screen. One cassette program covers elementary math, while a game tape creates colorful western gunfighters that duck behind movable cacti.

Atari's $190 Video Computer System has a combat package with steerable missiles, cloud formations, and multiple fighter - versus - bomber combinations. Atari's $75 video pinball is "so addictive it's diabolical," the company warns. PS

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Chilton's books can help you maintain your car. And your standard of living.

You can do it yourself. Even if you've never opened the hood of your car.

These days, about the only thing harder than finding good repair work is paying for it.

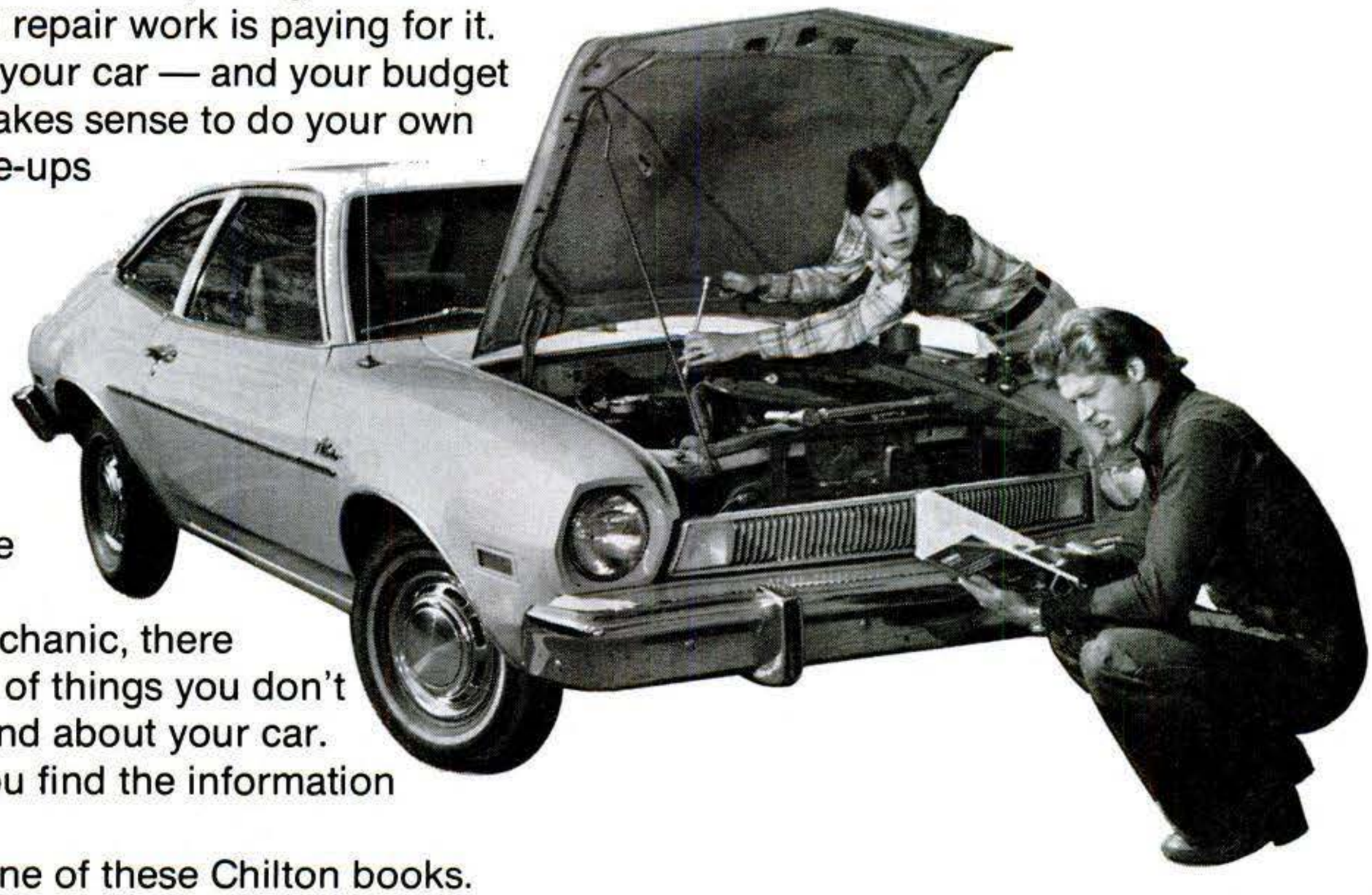
So, if you want your car — and your budget — to survive, it makes sense to do your own maintenance, tune-ups and repairs.

It's easier than you think. It's satisfying. And it can save you hundreds of dollars a year.

The only trouble is: unless you're a professional mechanic, there are probably a lot of things you don't know or understand about your car.

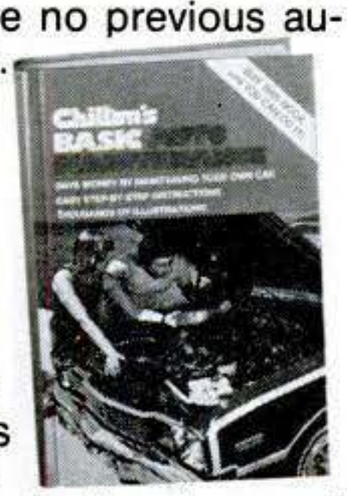
So where do you find the information you need?

Right here. In one of these Chilton books.



Chilton's Basic Auto Maintenance

This is the *first* maintenance book for people who have no previous automotive knowledge.



It gives you step-by-step instructions for every basic maintenance job.

From changing a headlight to adjusting a carburetor. Including all the tools and parts you need.

It covers most popular American and imported cars, and it's clearly illustrated with over 2000 photos and drawings.

This book can easily pay for itself the first few times it's used.

704 pages. Hardcover. **$8.95**

Chilton's Repair and Tune-Up Guides

No matter what kind of car you drive, American or imported, Chilton probably has a Repair and Tune-Up Guide designed specifically for it.

It shows you how to do your own engine tune-ups, troubleshooting and rebuilding.

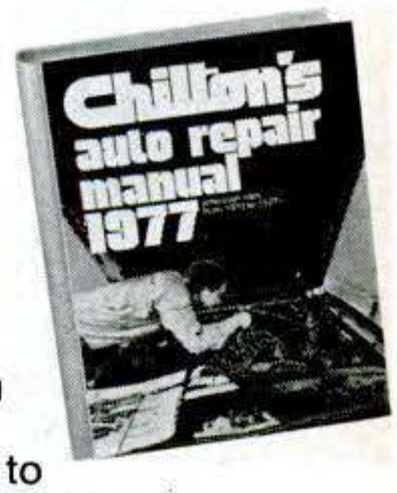
How to service and repair the fuel system, emission controls, drive train, suspension, steering and brakes.

Includes hundreds of photos, drawings, exploded views, diagrams and tables.

Paperback. **$6.95-$8.95**

Chilton's Auto Repair Manual All American cars — 1970-77.

This is the ultimate manual. The most comprehensive, up-to-date repair manual available anywhere.



It gives you complete step-by-step instructions for engine troubleshooting and rebuilding. Everything from gapping spark plugs to tune-ups to cylinder head reconditioning.

Also included are 12 major repair sections covering all of the other mechanical and electrical systems in your car.

Even the new emission control devices.

1128 pages. Hardcover. **$13.95**

May is Car Care Month. Buy one for Dad for Father's Day, June 19.

A book is a loving gift™

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Ask for them at your favorite bookstore or automotive retailer.

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Diesel Rabbit

surprisingly smooth and quiet, plus more mpg

Volkswagon offers a state-of-the-art diesel engine in a superb small car at an affordable price

By JIM DUNNE and RICH CEPPOS

Dwindling petroleum resources, a federal 27.5-mpg requirement for 1985, strict exhaust-emissions standards, and worldwide inflation have compelled auto manufacturers to search for more fuel-efficient and durable engines. One possible solution to this complex set of requirements: the diesel engine. But is the U.S. motorist ready for it? Volkswagen is betting that he is. It has taken the diesel design, refined it to a point VW feels will be acceptable to the average buyer, and now offers it as an option on the Rabbit.

Volkswagen is not the only company that feels the diesel has a bright future. In 1978, Chevrolet and GMC pickups, and Oldsmobile sedans will have diesels for the first time. Dodge pickups will have the diesel, and Peugeot, Mercedes-Benz, and International all offer it now. To see how the diesel Rabbit compares with the gasoline Rabbit and gas-powered cars in general, we put it through our standard track testing, then lived with it for almost 2000 miles.

We found that the diesel Rabbit offers all the virtues of diesel power—greater fuel efficiency and a promise of longer engine life—with few of the drawbacks, such as excessive smoke and noise, poor performance, and complex operation. The Rabbit's diesel engine is based on the same block as the gasoline version. It also shares the crankshaft and connecting rods with the gas engine. From there, the designs diverge. The diesel gets its own pistons, which are designed to withstand the more intense power pulses of its 23.5:1-compression-ratio engine. The cylinder head is also unique to the compression ignition engine and features a Ricardo-type combustion-chamber design that swirls the mixture for more complete burning. The gasoline engine displaces 1588 cc and develops 78 hp; the diesel, with a smaller cylinder bore and 1471 cc, develops 48 hp.

You start the diesel by pulling out the fuel-injection advance knob, positioned where a choke would normally be. This eliminates the big preliminary cloud of smoke. You twist the ignition key to the first detent and hold it there. A red light on the dash indicates that the glow plugs are heating the combustion chambers. When the light goes out a couple of seconds later, you twist the key all the way and the diesel starts up. When the engine is warm, you start it normally. The Rabbit's diesel comes to life with a clatter, and for the first few minutes it sounds much like ball bearings rolling around inside a coffee can. Once the

Continued

Fuel mileage (mpg)

	VW Diesel
EPA highway	52
EPA city	39
California EPA city	39
California EPA highway	52

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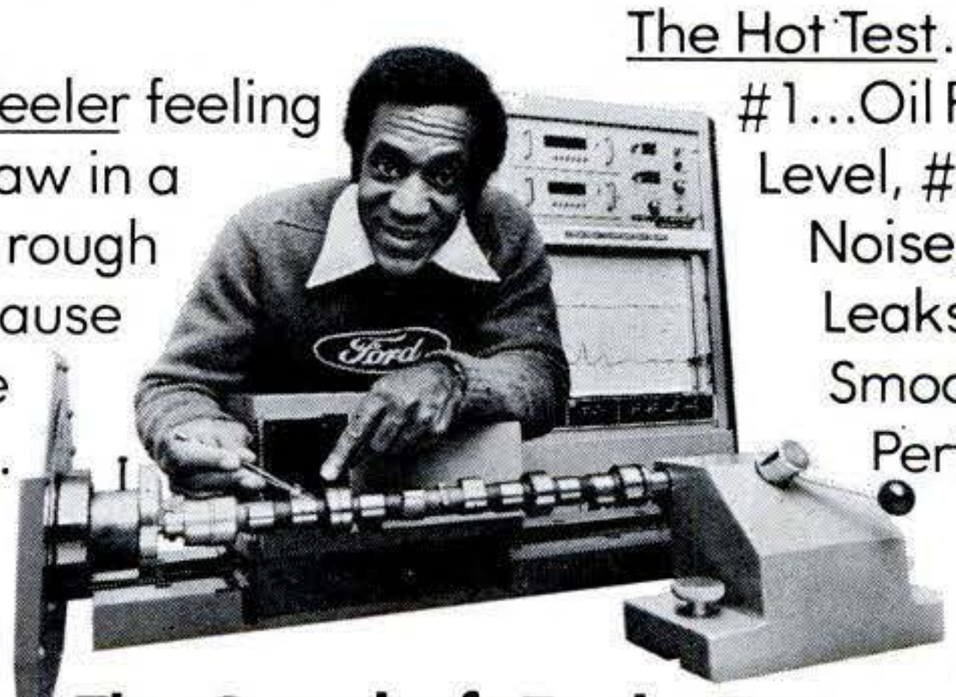
It's tough to get to be a Ford, Mercury or Lincoln engine.

All Ford Motor Company engines are the result of one tough test after another.

Here are just a few.

This is a Camshaft Feeler feeling a camshaft...'cause a flaw in a camshaft could mean a rough running engine. That's 'cause the camshaft makes the valves open and close... exactly when they're supposed to.

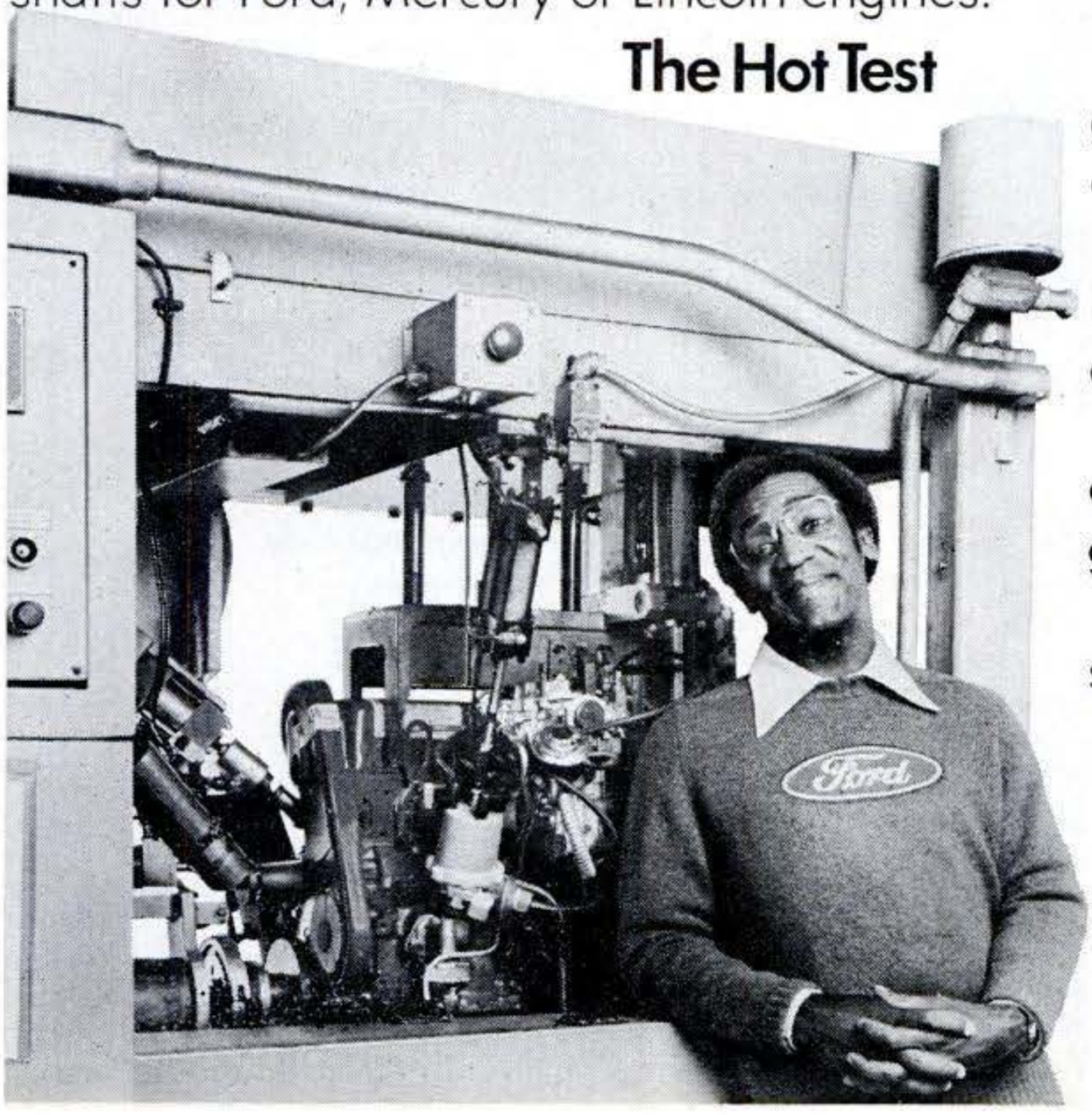


The Camshaft Feeler Test

See, if there's even the eensiest-weensiest flaw in the shape of the camshaft...the Camshaft Feeler finds it. See that big bump on the graph? That's just a teenie little piece of tape I stuck on a camshaft...and the Camshaft Feeler found it.

It can find a flaw down to .000050 of an inch. It's tests like this that help keep you from getting a rough running engine.

That's why...8 hours a day, 5 days a week ...someone...somewhere is feeling camshafts for Ford, Mercury or Lincoln engines.



The Hot Test

Any engine that really wants to be a Ford Motor Company engine has to pass The Hot Test...an' that's ten tough tests!

#1...Oil Pressure, #2...Manifold Vacuum Level, #3...Ignition Timing, #4...Engine Noise, #5...Coolant Leaks, #6...Fuel Leaks, #7...Oil Leaks, #8...Idling Smoothness, #9...Overall Engine Performance, #10...Exhaust Leaks.

Every engine Ford Motor Company builds has to pass every one of these 10 final tests.

If it don't...it don't get to go into a Ford Motor Company car.

This Red Hot Test is no picnic. It's the Engine Durability Test. Engines that get picked for this tough test have to run on a dynamometer for 100 hours at throttle speeds up to 125 mph.

The Red Hot Test

Exhaust pipes get red hot...hot enough to toast a marshmallow. After one-hundred-red-hot-hours, engines get torn down and checked out...for wear and tear.

Now that's a tough test. And any engine design that can't take the heat...doesn't get to go into a Ford Motor Company car.

Tough testing makes for tough engines so at Ford Motor Company we do a lot of it.

Ford

It's simple. Ford wants to be your car company.

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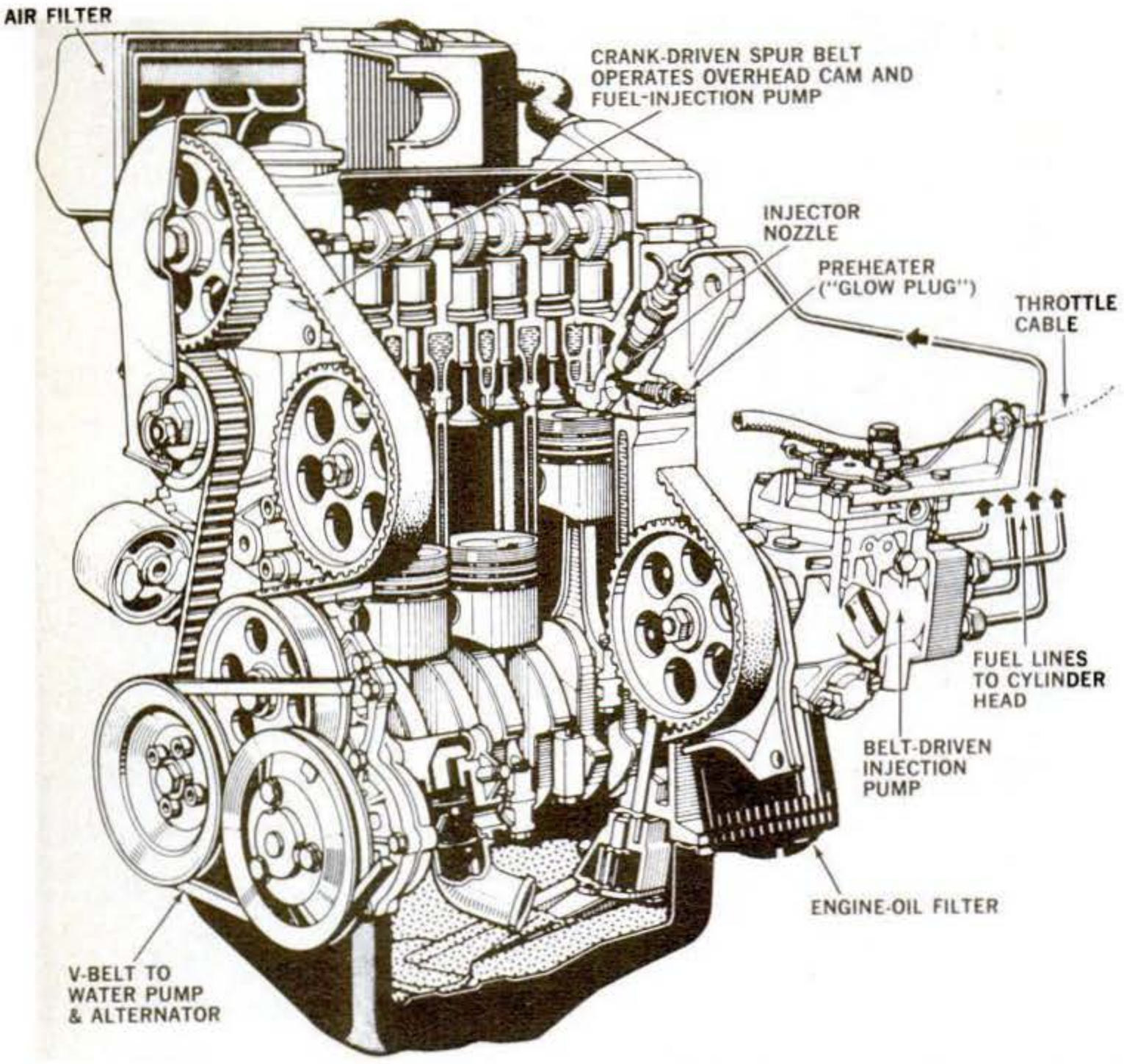
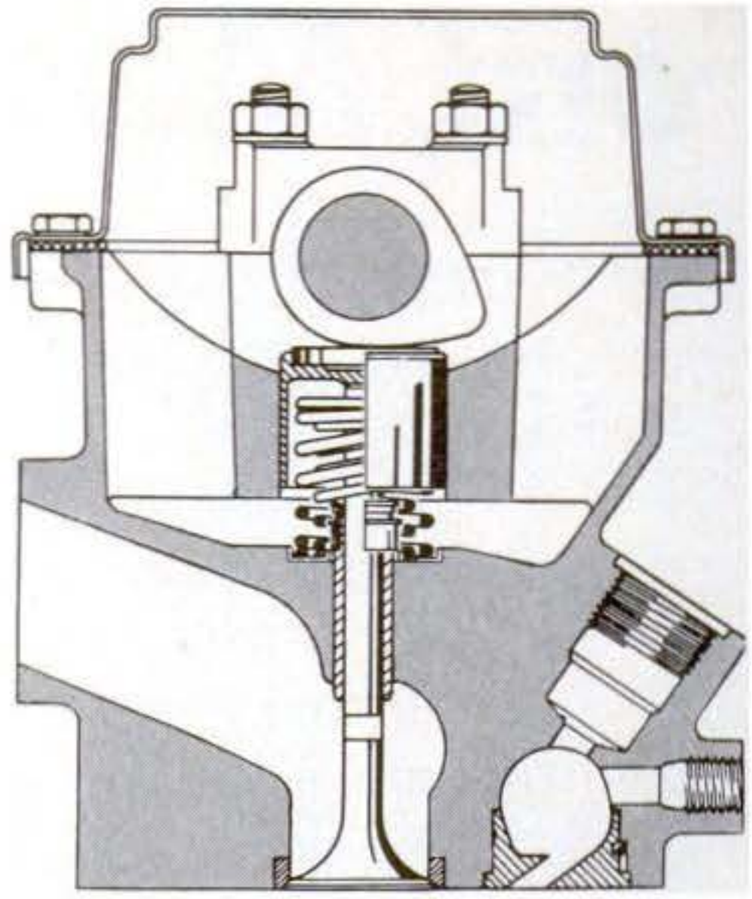
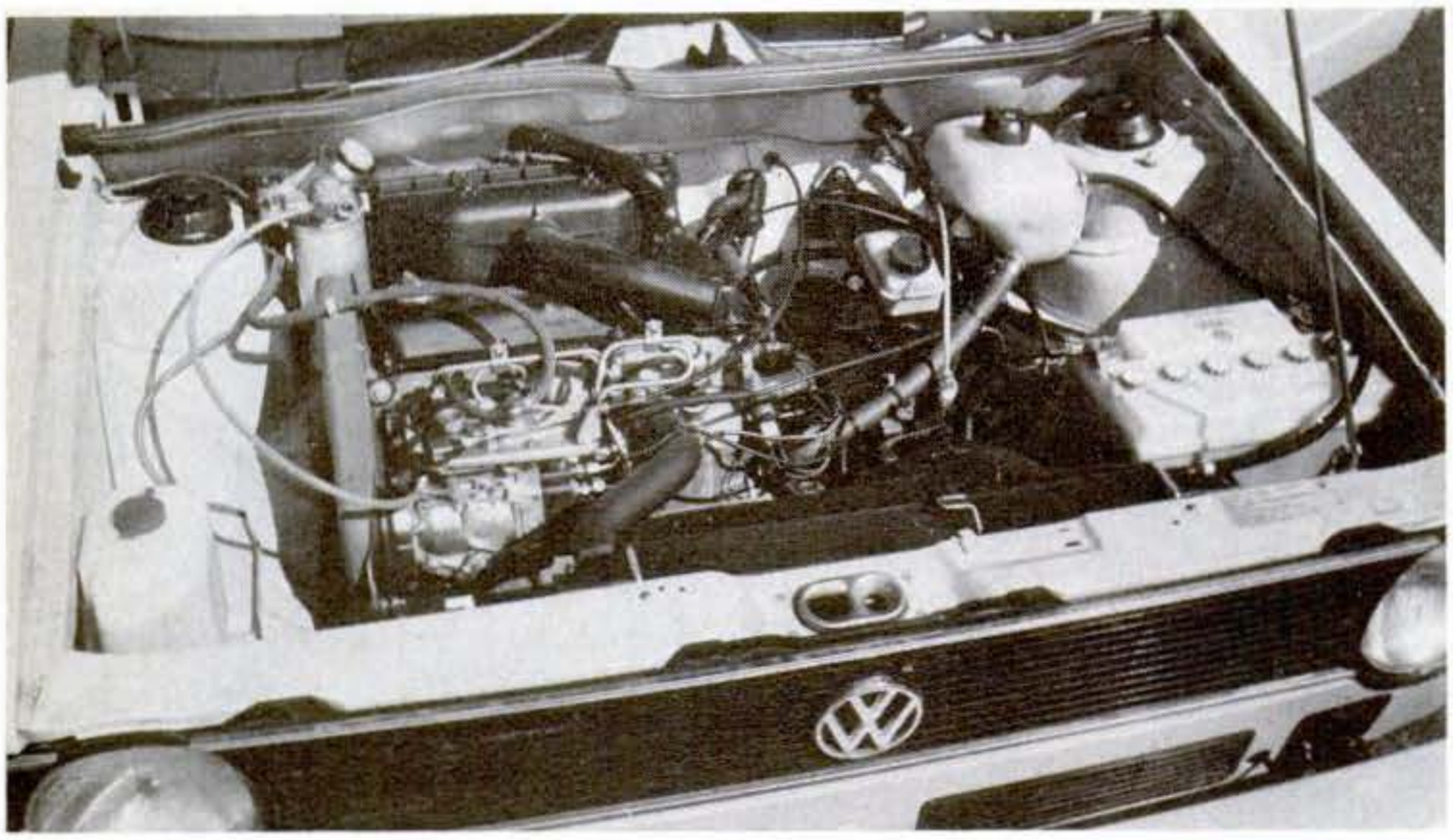




Turbulence caused by Ricardo-type combustion-chamber design mixes fuel more thoroughly for more efficient combustion. Initial combustion begins in small chamber, then moves down tube to main combustion chamber. This eases wear on internal parts and reduces noise.

Engine block, crankshaft, and rods of diesel Rabbit are shared with gasoline engine. Cylinder head, fuel-injection unit, pistons, oil and fuel filters, and other accessories are its own.



Diesel Rabbit meets all emissions standards without add-on smog gear.

engine is warmed up, this sound nearly disappears.

Performance is the diesel's weakest area. Around-town acceleration is adequate, and there's enough power for merging onto expressways, but you must work up through the gears. The diesel's 0-60-mph time of 22 seconds is more than eight seconds slower than the gas Rabbit's. That's slow, but not unacceptable. In fact, the car feels much quicker than it is, thanks to a judicious selection of gear ratios. Up to 45 or 50 mph the acceleration is more than adequate; after 50, however, it flattens out. That's where the 0-60-mph time slows down the most.

What you get in return for this drop in performance is mileage that is truly amazing, and far superior to the gas version. The EPA rates the diesel at 52 mpg highway/39 mpg city, while the gas Rabbit comes in at 43 highway/29 city. If you drive 15,000 miles a year, the EPA figures you'll pay only $188 for fuel (at 55¢ per gallon) with the diesel; you'll spend $348 with the gas Rabbit. So in one year you can make back all but $10 of the additional $170 you paid for the diesel option. In our real-world testing, we found that the diesel returned 45 mpg when cruised at a steady 55 mph; in another car

Continued

PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars, and that other seemingly identical cars may vary in performance. Also, weather conditions (noted in our spec table) vary from test period to test period. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	VW Diesel
Fuel economy	5
Acceleration	1
Braking	4
Handling	3
Maneuverability	5
Ride comfort	2
Quietness	0
Roominess	3
Visibility	4
Entry/exit ease	3

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Kings, 15 mg. "tar," 1.0 mg. nicotine; Longs, 18 mg. "tar," 1.3 mg. nicotine, av. per cigarette, FTC Report Dec. '76

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PS engineering editor E. F. Lindsley managed nearly 47 mpg without any special driving techniques.

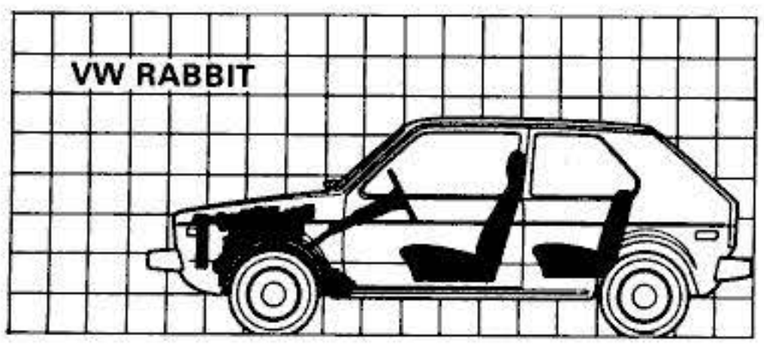
Smoke-free driving

VW has succeeded in eliminating two major diesel-related problems: excessive smoke and noise. The previously mentioned fuel-injection timing-advance knob virtually eliminates the white smoke (caused by water vapor and unburned fuel in the engine) that occurs when starting most diesels. During full-throttle acceleration, only a wisp of black smoke trails the car; at other times no smoke is visible.

While the diesel Rabbit is not as quiet as the gas version—especially during starting—it is not unsettlingly noisy once warmed up. Staff members as a whole were pleasantly surprised at how quiet the diesel was; on long trips the noise level was never loud enough to be annoying. You would have to have a keen ear to detect that you were driving anything other than a gasoline-powered car.

Surprisingly, VW says you won't save gobs of money on maintenance, even though the diesel Rabbit has no points or plugs. The 7500-mile service interval for oil changes is the same for gas and diesel cars (that's a long interval for a diesel), and both must have their valves adjusted every 15,000 miles. VW says it's not uncommon for fuel injectors to go for 100,000 miles or more. Over the long run, the total for parts and labor for required service on gas and diesel Rabbits is within a few dollars of one another.

Engine durability is where you'll save money with the diesel. VW claims that, based on bench tests, the diesel should last about twice as long as the gasoline engine before it needs major overhauling.



An expert's opinion

About the only problem we foresee with the diesel Rabbit concerns starting in extremely cold weather. Engineering editor Lindsley, a diesel expert, says the Rabbit's fuel system is likely to have trouble pumping frigid #2 diesel fuel—which at low temperatures (about −20° F) thickens and is sometimes filled with ice crystals. Switching to thinner #1 fuel might help, but only time will tell. A fix (in the form of a rear-mounted electric-fuel pump to push the syrupy fuel to the engine) shouldn't be hard to incorporate, Lindsley says.

Another thing that worries Lindsley is the lack of a manually controllable air-shutoff valve to stop the engine from "running away" if the governor or electrical shutoff fails. But VW assures us that the design of the combustion chamber will keep the engine from revving high enough to self-destruct under any circumstances.

The best thing the diesel Rabbit has going for it is price. Until now, if you wanted a diesel car, you had to pay upwards of $8000 for a Peugeot or Mercedes. The Rabbit, equipped with the mandatory custom performance package, lists for only about $4250. For that you get a state-of-the-art diesel system in what is already one of the best all-around small cars. And if you don't mind the mild performance, you'll find the diesel Rabbit an enjoyable automobile, as well as a wise long-term investment. PS

Serviceability ratings

How easy is it to service our test cars? For example, is that heater hose clamp out in the open where it can be reached easily? To give you an approximation of how difficult it is for a typical person to perform various service operations on the cars, we examine each vehicle. Here's what the numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty, no worse or better than most other cars; 4, easy; 5, very easy.

	VW Diesel
Checking fluid levels:	
Battery	5
Master cylinder	5
Windshield washer	5
Engine oil	4
Coolant	5
Checking engine:	
Spark plugs	n.a.
Distributor	n.a.
Carb adjustment	F.I.
Oil filter	5
Oil fill	5
Replacing hoses:	
Top radiator hose	4
Lower radiator hose	3
Heater hoses	2
Changing bulbs:	
Headlights	5
Taillights	5
Front running lights	5
Front parking lights	5
Front directionals	5
Rear directionals	5
Rear running lights	5
Checking fuses	3
Spare-tire accessibility	5
Changing belts	2

VW Diesel—specs, dimensions, and test results

	VW Rabbit Diesel
DIMENSIONS (inches)	
Wheelbase	94.5
Overall length	155.3
Overall height	55.5
Overall width	63.4
Track, F/R	54.7/53.1
Ground clearance	4.9
Front head room	37
Front hip room	48
Front leg room	42
Rear head room	34
Rear hip room	50
Rear leg room (min.)	36.5
Min. knee room	4.75
Couple distance	29
SPECIFICATIONS	
Engine type	4 in-line
Displacement (cu. in./cc)	89.7/1471
Compression ratio	23.5:1
Carburetion	F.I.
Net hp @ rpm	48 @ 5000
Net torque @ rpm	58 @ 2500
Transmission	Manual 4-speed
Axle ratio	3.90:1
Tire make	Michelin
Tire type	Z X Radial
Tire size	155 SR 13
Steering	Manual, rack & pinion
Overall steering ratio	2.8:1
Turns, lock to lock	3.8
Turn diameter (ft.)	31.2
Front suspension	Independent MacPherson struts, coil springs
Rear suspension	Independent stabilizer axle, coil springs
Brakes	Manual
Brake type	Disk/drum
Brake swept area (sq. in.)	212.35
Fuel tank (gal.)	10.9
Trunk space (cu. ft.)	12.4
Liftover height (in.)	30
Curb weight (lb.)	1960
F/R weight distribution (%)	58/42
Trailer-towing capacity (lb.)	
Tongue weight	110
Total weight	2200
Basic price	$4249
(Includes	custom performance package [mandatory], $480; diesel engine, $170.)
Price as tested	$4249
Options on test car	None
TEST RESULTS	
Acceleration (sec.)	
0-60 mph	22
0-80 mph	42
25-70 mph	24
Brake test (cool)	
Stopping distance (ft.)	137
Pedal pressure (lb.)	120
Efficiency (% of 1 g)	100
Disk temperature (°F)	145
Brake test (hot)	
Stopping distance (ft.)	136
Pedal pressure (lb.)	110
Efficiency (% of 1 g)	100+
Disk temperature (°F)	585
Interior noise @ 60 mph (dBA)	75
Handling test (mph)	60.0
Maneuverability (mph)	30.1

TEST CONDITIONS: Ambient temperature 65°F; relative humidity 40 percent; barometric pressure 30.1 inches.

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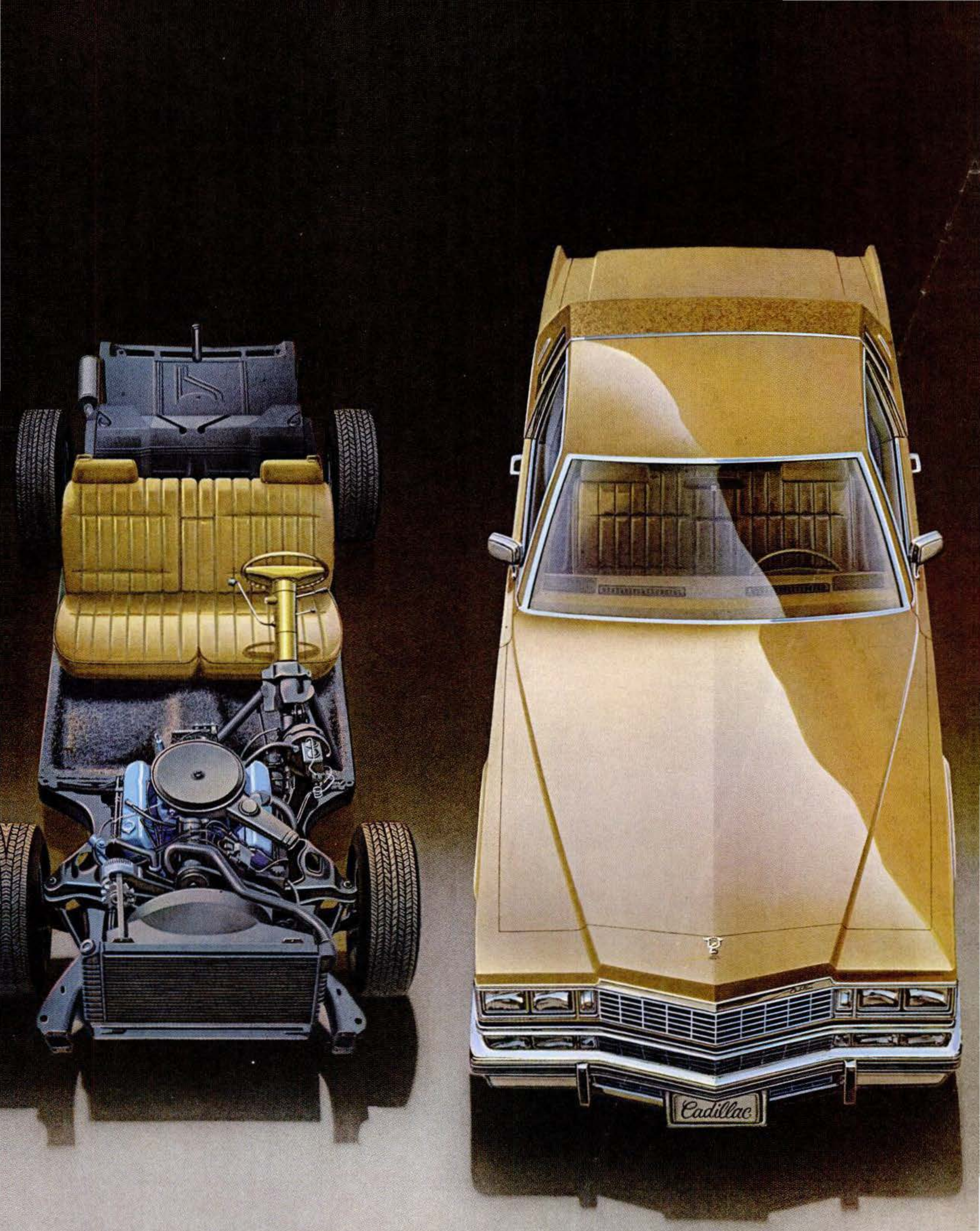

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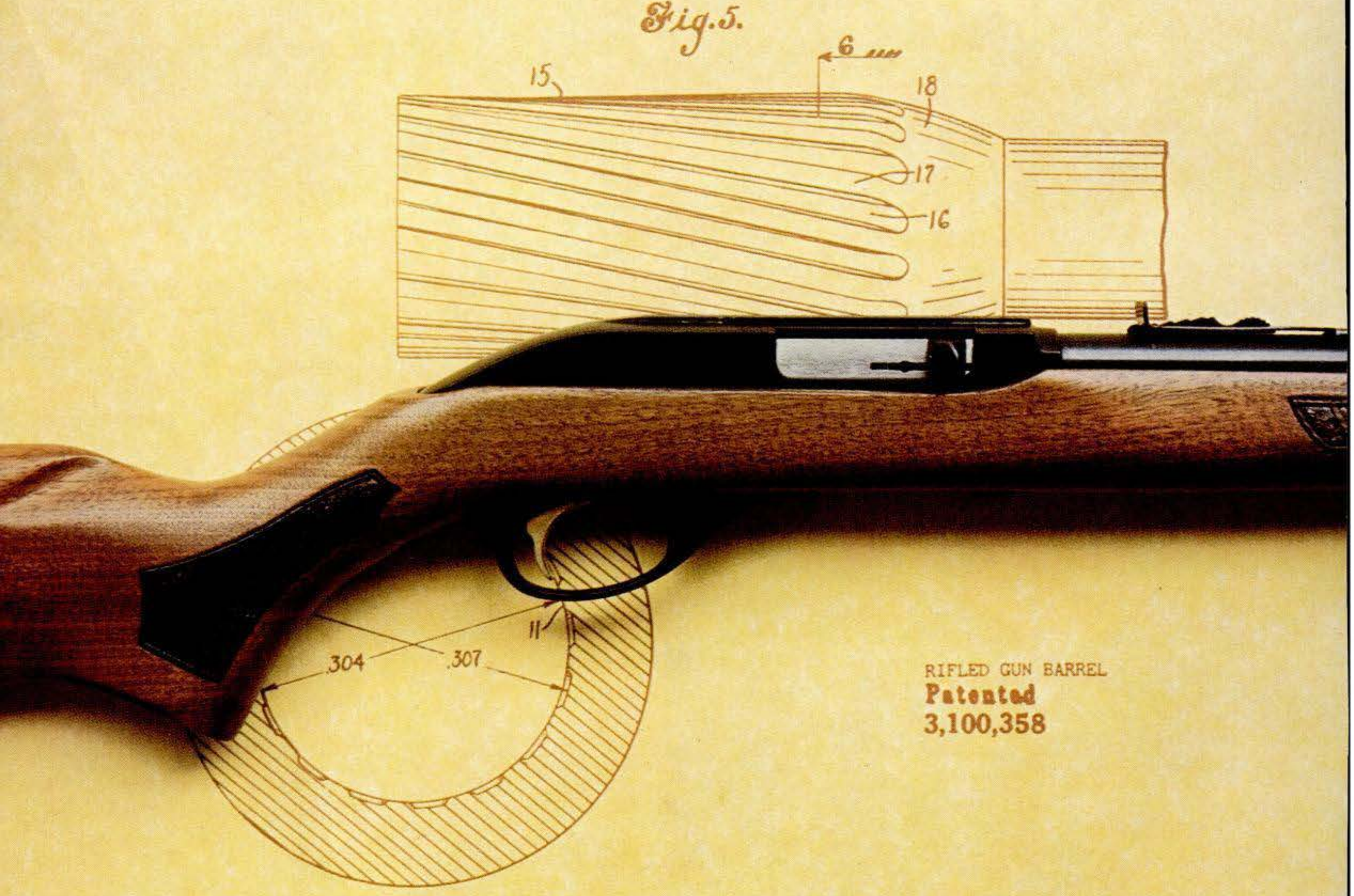
Before 1954, we made some of the most accurate 22's you could buy.



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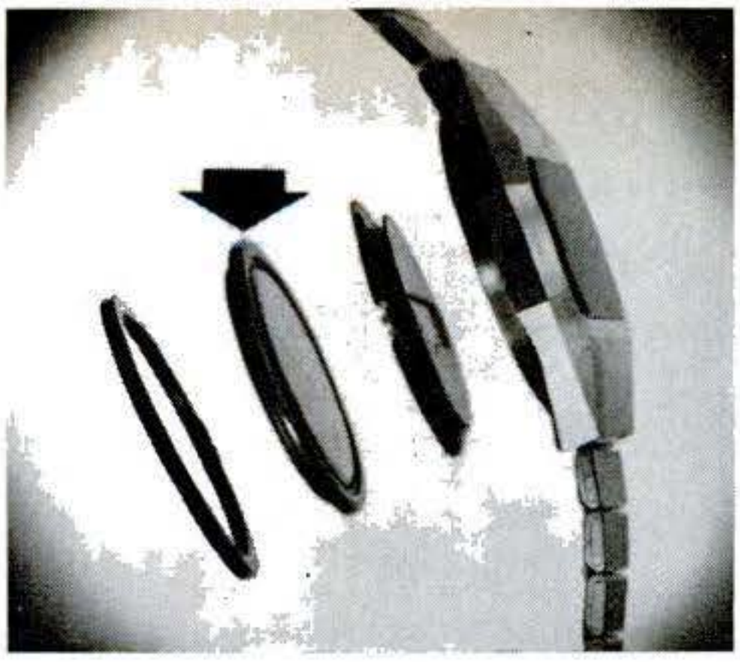


Lithium battery –long-lasting power for new LED watch

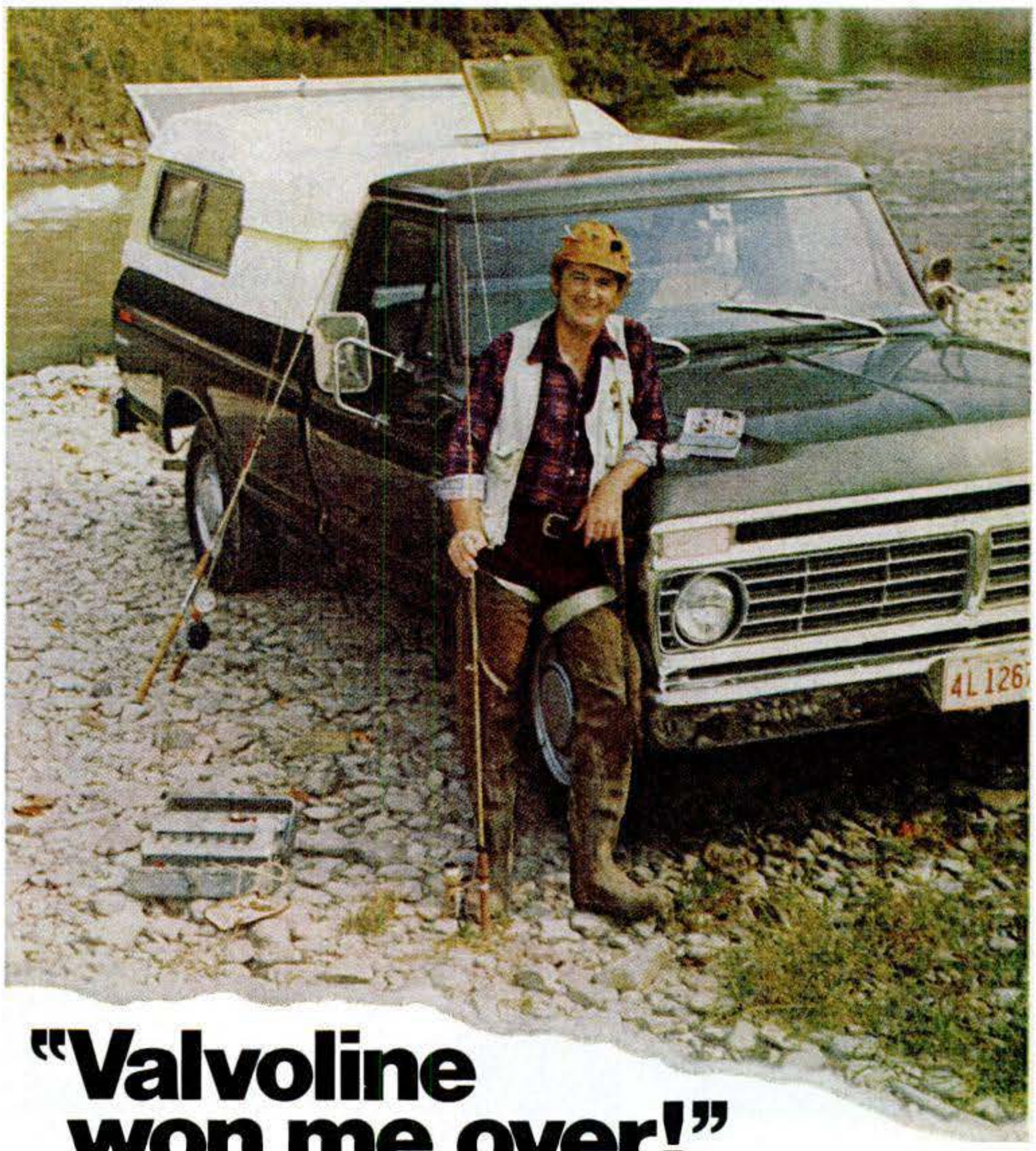
If you're the owner of an LED (light-emitting diode) watch, you may feel as if you've got a space-age timepiece with a stone-age battery. Many LED owners get only three to nine months' use from a set of 1.5V silver oxide power cells. That's annoying—and expensive. Also, the batteries may have only a two-year shelf life, which means that those replacement cells may be well into old age before they even see the inside of your watch.

Now National Semiconductor has introduced the first LED watch that uses a different power source —a lithium battery [PS, May '73]. A lithium battery has about twice the energy density (output of electricity for weight) of a silver oxide battery. National guarantees the cell for one year, and it should last considerably longer. The lithium battery also has a long shelf life. It will deliver 75 percent of its energy potential after 10 years of storage.

Even the shape of the new battery seems ideal for watches. It looks like a half dollar with a rim around it (an arrow points to it in the photo). The battery itself is the watch back, so the watch can be thinner.

Initially, one 3V lithium cell may cost more than two 1.5V silver oxide cells. Once production is in full swing, however, the lithium batteries should be cheaper. National's suppliers are Honeywell and Eagle-Picher.

The lithium-powered LED watch now on the market is a man's six-function model (hours, minutes, seconds, day, date, month). Suggested retail price is $49.95. Some time soon, National will bring out more LED models, and even some lithium-powered liquid-crystal-display watches (with batteries guaranteed for three years).—*E. Smay*



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Ingenious new gear for **rock climbing**

On Grand Rappel at West Virginia's Seneca Rocks, a climber walks backward down a nearly vertical 150-foot cliff, supported entirely by his Goldline rope and figure-eight descending ring. Fortunately, equipment is very reliable.

Fancy equipment is required for some climbs. Here, climber is arranging her gear to get at items she'll need first. Lightweight helmets, designed for climbers, cost less than $30.

By TOM MORRISEY

Rock climbing has enjoyed a tremendous spurt in popularity during recent years. Lured by its aura of excitement and danger, thousands of recruits are finding in the sport a sense of accomplishment and an unequalled appreciation of the outdoors [see "Rocks in My Head," PS, April '69]. Not surprisingly, there's also been a proliferation of new climbing gear, with improved versatility, strength, and safety. Even the climber's basic protection system has changed, not so much for the sake of the climber as for the sake of the cliff. [For "How a Rock-Climbing Protection System Works," turn the page.]

For safety, climbers must have some means of anchoring their equipment—and sometimes themselves—to the rock. Traditionally this has been done with pitons, hardened steel spikes driven with hammers into the rock face. Problem: Pitons scar the rock. Routes with regular climbing traffic slowly become victims of man-made erosion.

Now climbers are using a new kind of anchor, the chock. Chocks are devices of stainless steel or aluminum that are finger-placed into cracks. Like a judo expert using his opponent's force to defeat him, a chock uses the force of a fall to wedge itself deeper into a crack.

Chocks are used in two ways: They can be jammed or cammed. Jamming, or stopping, is employed in cracks that narrow toward the bottom. With a chock that is basically wedge-shaped, you just slide it into the crack until it stops. Other chocks can be cammed as well as jammed. Camming is done with an eccentrically shaped chock, which under load, rolls over and wedges itself sideways in the crack. Anyone who has gotten an L-shaped sofa stuck in a hall knows the effect. The demise of pitons has brought about a radical change in hammer design. Where climbing hammers once had large heads for driving, they now have a long hooked pick to fish out chocks from deep cracks. The hammer head is still used occasionally, to test permanently fixed pitons (found on some established routes) and to seat a chock in a narrow crack in less than comfortable situations.

Even the climber's rope has

[*Continued on page 44*]

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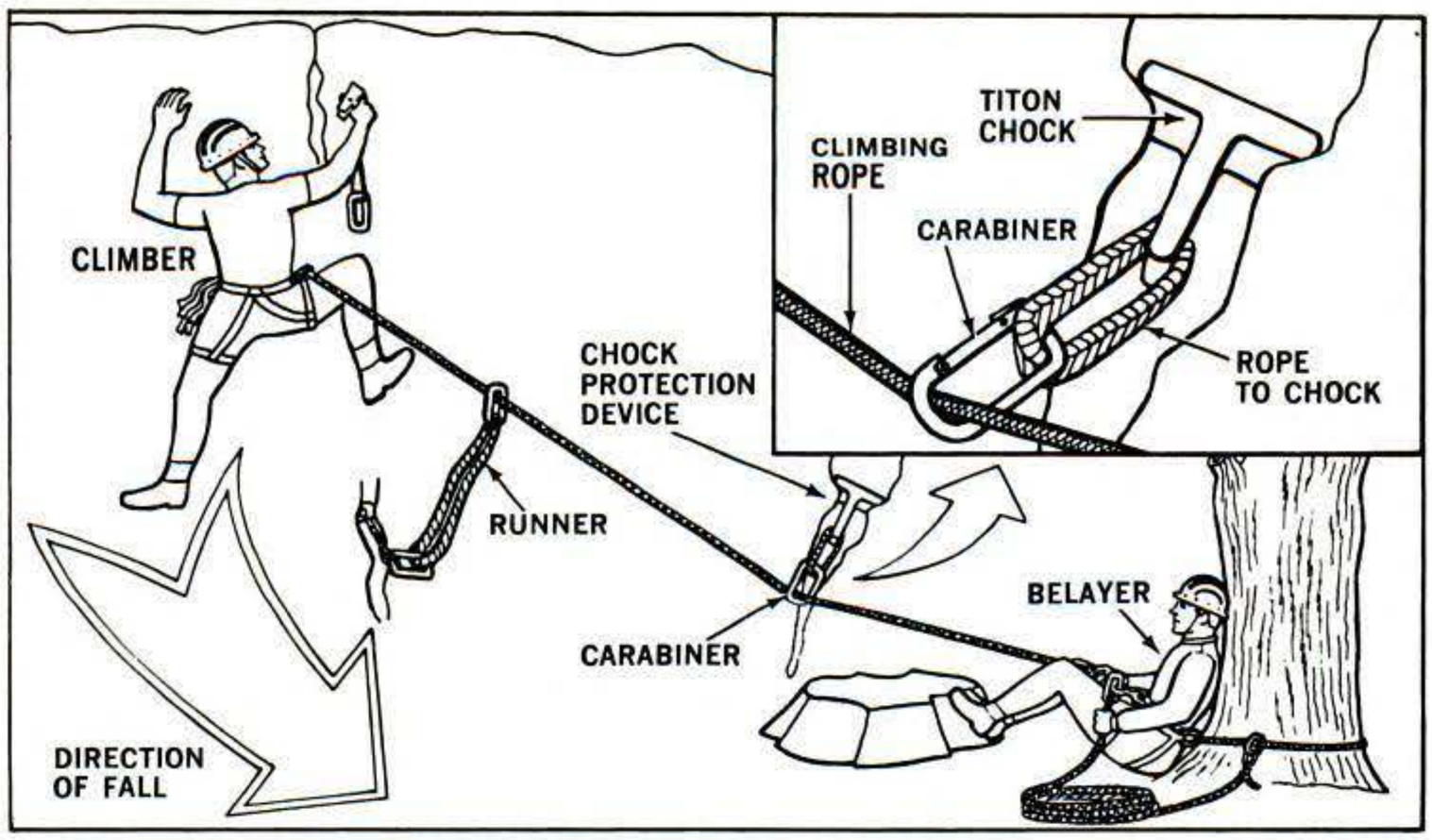
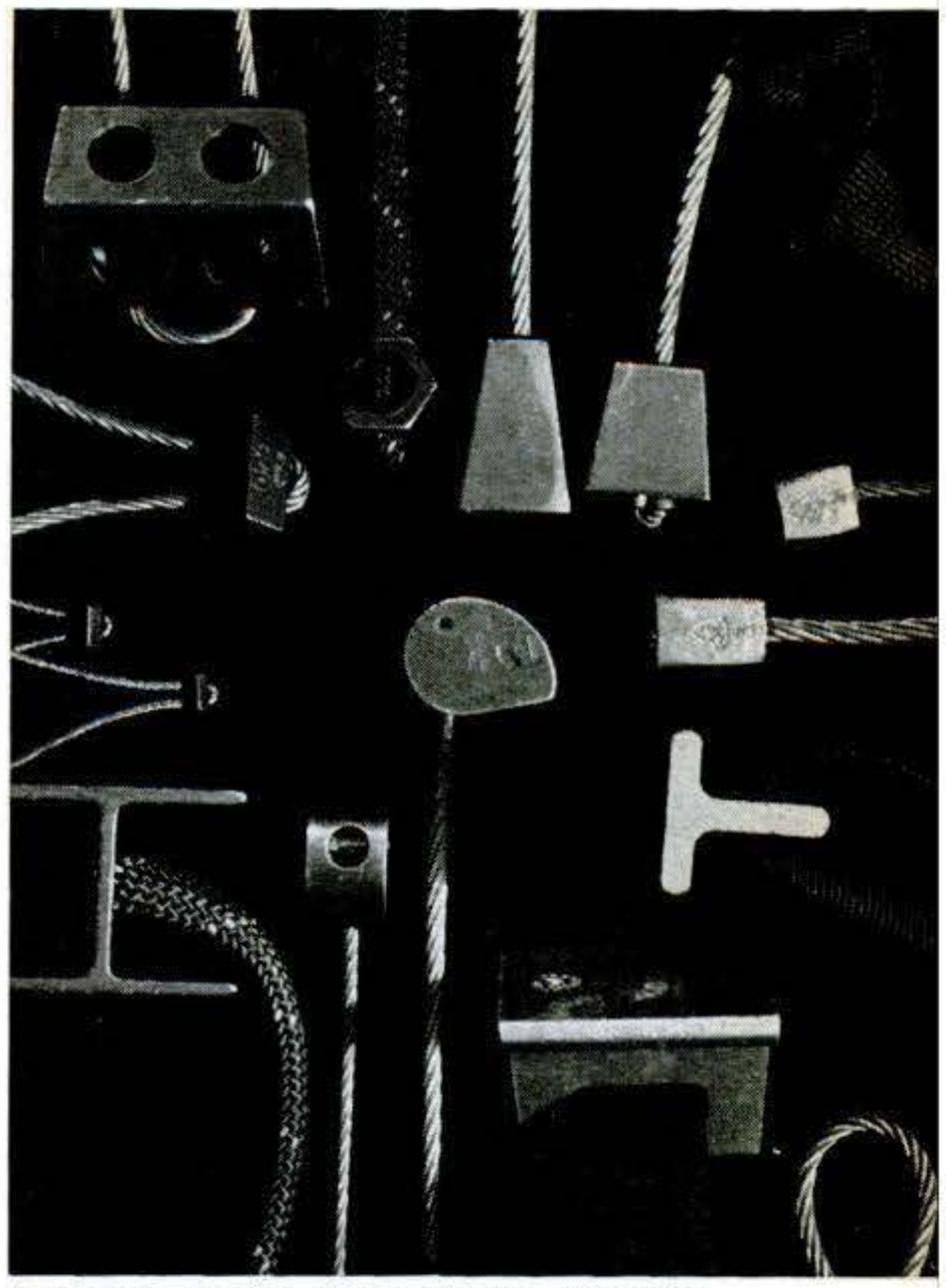
How a rock-climbing protection system works



The climbing rope is attached to a sturdy anchor (here a tree), then stacked so that it can be fed freely, without kinks. The belayer then either passes the rope around his body or puts it through a belay device on his harness. With his hand constantly on the rope, the belayer controls its tautness. The object is to keep a potential fall as short as possible without making the rope so taut that it inhibits the climber.

The other end of the rope is attached by harness to the climber, who places protection devices, chocks (here a cammed Titon), in cracks as he climbs. On a cable hanging from the chock, he snaps a carabiner, an aluminum link with a spring-loaded gate section. Into the carabiner he also clips the rope (see inset). Now, he can fall only until the rope goes taut over the carabiner. If injured, he can be lowered by the carabiner used as a pulley. On the second chock, a loop called a runner was added to keep the rope running in a fairly direct line. Once on top, the climber belays the person below, who removes the protection as he ascends.



Chocks come in many shapes and sizes. Our sampling, clockwise from lower left: I-beam Beamchock; five sizes of Hexachocks (from CMI); two each of Foxheads, Arrowheads, and Titons (all from Forrest Mt.). CMI's Kirk's Kamms (two) are in center and at 7 o'clock.

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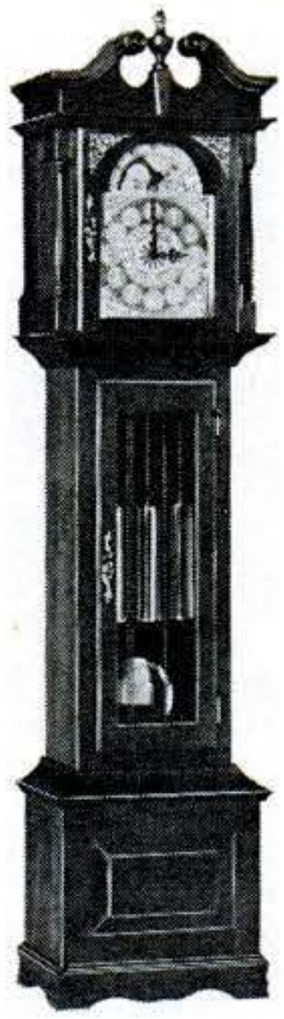

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Fairhope, Alabama 36532

changed. The traditional standard, Goldline twisted nylon rope, is still popular for its durability and lower price (about $50). But newer synthetics, which may cost twice as much, have advantages. One such rope, the Edelweiss Everdry from Climb High, is made to resist kinking and water absorption, has a smooth surface to reduce drag, and stretches when snapped —thus acting as a shock absorber during a fall.

Common to all climbing gear is a high strength-to-weight ratio. Chocks, ropes, and harnesses typically hold thousands of pounds of dead weight and hundreds of pounds in a fall.

Our photos show a number of other ingenious new devices that make climbing a better, safer sport. But all the gear is useless if handled improperly. The best way to learn is to attend a climbing school —then buy gear as you learn. PS

New-generation climbing hammer (Forrest Mountaineering's Mjollinar III) has head for seating chocks and testing pitons, long pick for prying wedged chocks from cracks. Fiberglass-handled hammer has three different picks. Allen wrench removes screws that hold pick.

Seat harnesses like GPIW's Whillans harness (above) and Forrest Mountaineering's Swami Belt (not shown), fit around waist and legs only. Full-body harness, like Climb High's Freedom (right) and Edelweiss (not shown) distributes shock of a fall throughout body.

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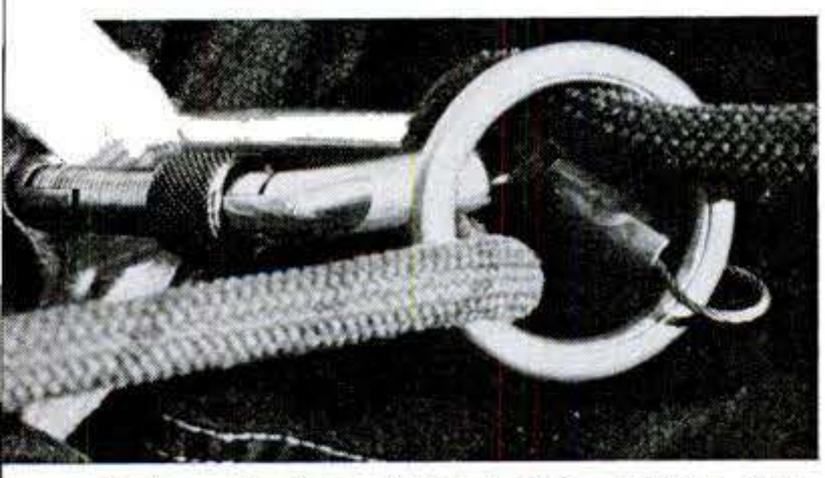
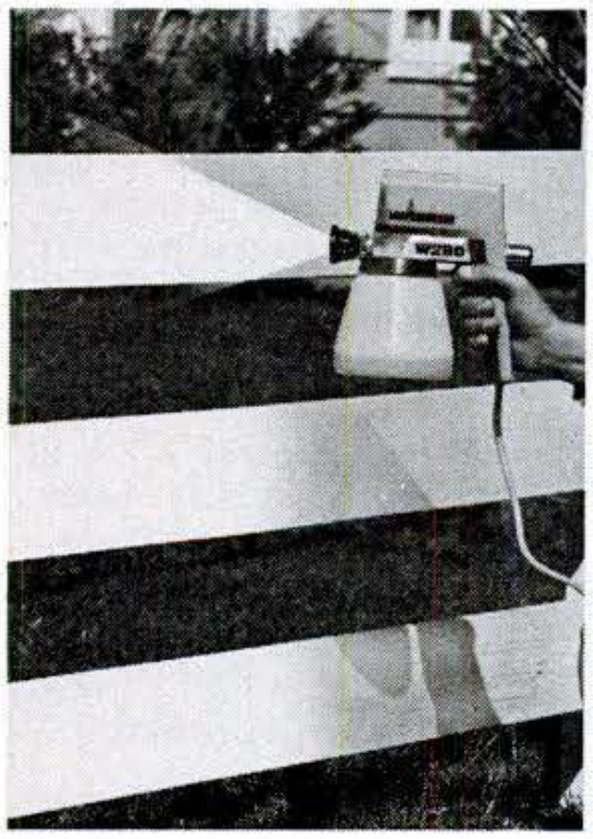
Climb High, Inc., 227 Main St., Burlington VT 05401; **Colorado Mountain Ind. (CMI),** Box 44179, Cincinnati OH 45244; **Forrest Mountaineering, Ltd.,** 1517 Platte Street, Denver CO 80202; **Great Pacific Ironworks (GPIW),** Box 150, Ventura CA 93001; **Lowe Alpine Systems,** 1752 N. 55, Boulder CO 80301; **REI Co-op,** Box 22090, Seattle WA 98122; **Seattle Mfg. Corp. (SMC),** 12880 Northrup Way, Bellevue WA 98005.
(*Also good sources of information on rock-climbing schools.)

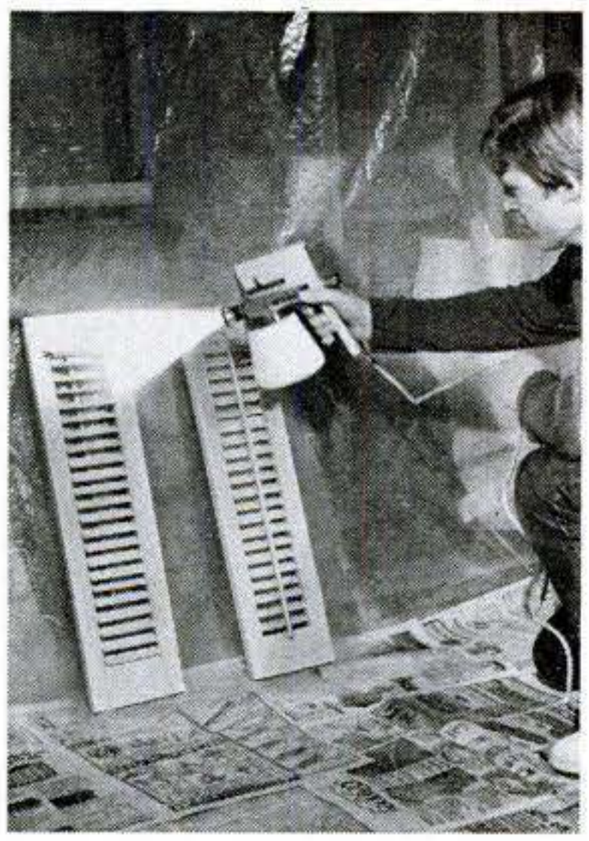


Belay device, from Lowe Alpine Systems, eliminates need to pass rope around body for belaying. Simple tug on rope by belayer will lock rope against carabiner, arresting the climber's fall. Device is attached to belayer's harness.

CMI's eight-ring rapelling device, shown in closeup and above right in use, is attached to climber's harness with carabiner. Climber pulls lightly on ropes below device, creating friction that brakes him and controls descent.

Handle-like Jumar Ascenders slide freely up rope for easy climbing, but toothed cams lock in place when weighted. Nylon-web stirrups allow use of feet, too. Jumars, designed by Swiss birdbander to reach eagle nests, are used in pairs, and sold in the U.S. by REI Co-op for around $60.





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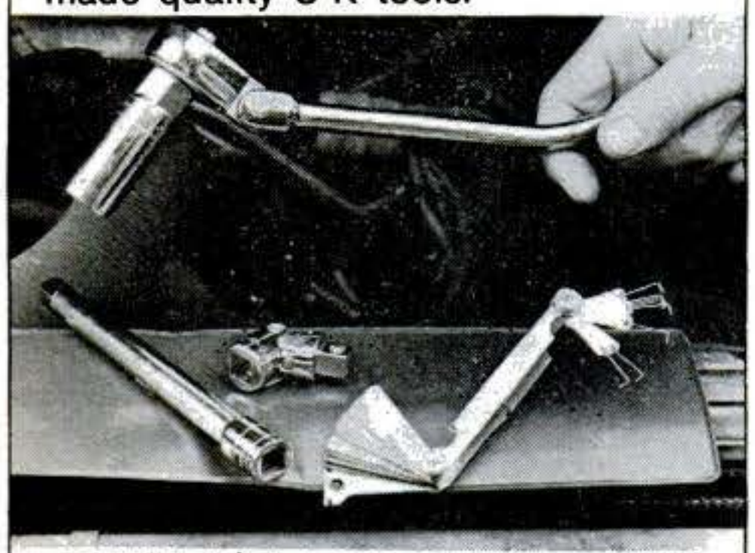

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Converting to other fuel

I have a 1969 Chevrolet C-10 pickup that I want to convert to propane gas or kerosene. Can you give me any suggestions as to the best method of making the conversion?

Gasoline now costs $2 per gallon here, and is likely to go up to $2.50, whereas kerosene costs only 35 cents a gallon. Will the engine run efficiently on kerosene? What I have in mind is to start and stop the engine on gasoline and switch over to kerosene for running, in a similar manner to the dual-fuel engines—started on petrol and switched to kerosene for running—made by the Kohler Company.

I would appreciate your recommendations on the conversion procedure, and sources of kits or carburetors to undertake this job. It is my intention to convert other vehicles in my fleet if this works out satisfactorily.

S. A. Burke, Kingston, Jamaica

Your answer requires a book; I only have a paragraph. Kerosene is out from the standpoint of being easy, efficient, and practical. It burns so slowly and is such a different fuel from gasoline that combining them would be too complex. Propane, on the other hand, is comparatively easy. Write Impco Carburetion, Inc. (16916 S. Gridly Rd., Cerritos, Calif.) for a carburetor-conversion kit and you can change over quickly and efficiently and get very good service. You can expect some exhaust valve and seat trouble, though, because of the lack of lead for valve-face lubrication. You need to put in hard valve seats and hard valves, such as those with a Stelite face.

Confused about oil filters

I'm confused! In 1976, *Popular Science* had an in-depth story about Mobil 1 and other synthetic engine lubricants. I purchased a case of Mobil 1 and took the advice of that article, which recommended the depth-type filter. I have put 12,000 miles on my engine, and like it very much. But the March '77 report by W. O. Koehler states that extended-area filters are better than depth filters.

Al Goetz, Washougal, Wash.

You're confused? So am I. Toilet paper, compound, in-depth, extended-area heat-type—hell, I've seen them all. Some even look like small oil refineries. But you take every one of them and pull the oil pan at 50,000 miles and you get a half to a pound of dirt and residue of all kinds. So none truly does the job. A paper filter with no holes will pass only what is small enough to go through, and that's not much. The real trouble is that until the oil is picked up and run through the oil pump it's still in the engine, flying around cylinder bores and other places. The best filter can't do much about the junk that stays in the oil pan and engine.

That March report was comparing manufacturers' claims, not making recommendations. Change your filter every 5000 miles and I bet you do as well as anyone, in the long run. Remember: I'm talking about quality filters like Fram, AC, and Purolator—because there are some real ripoffs that look alike and are sold under fancy names. I'd like to name a few but don't have time to live in court.

Piston noise normal?

I have a 1977 Buick Le Sabre V6 with 1800 miles. When I take off and it's cold, I get a clattering noise in the engine—the colder it is the louder the clatter. After driving seven to 10 blocks the motor warms up and there's no noise. Is this characteristic of V6's? Will driving this way harm the engine?

Paul Johnson, Detroit Lakes, Minn.

The noise when the engine is cold is caused by high piston clearance. That really won't hurt anything or cause accelerated wear. There's nothing you can do about it short of putting in tighter pistons.

Now I guess the problem is this: Should Buick take your noise out? Seems to me it's the company's responsibility. Try a calm, sensible call or letter to Buick customer relations.

Plastic vs. metal cam sprockets

I have a '72 Couger 351 Cleveland with 51,000 miles and was told that the teeth on my timing gear are made out of plastic or some kind of fiberglass, which makes things quieter, but wears faster. About how many miles are these gears good for and what warnings does an engine give when it's time to replace gear and chain? Right now my engine is in perfect shape except for a pushrod or two making noise.

David K. Mazeikas, Salem, Ore.

My experience with those types of cam sprockets has been good. Matter of fact, we use them in race cars quite a bit and have little trouble with them. But I have seen some that give no warning and go to hell. And usually in a Ford. But, generally speaking, I'd say they will wear less than the chain and I pre-

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fer them to a metal gear. The only external check is to pull the distributor cap and compare rotor motion to crankshaft motion when the crank is hand-turned with a wrench—and that's a guess at best.

Worried about arcing

I have a 1974 Ford Gran Torino with a 351-c.i.d. engine with electronic ignition. The spark plugs are number ARF-42, and the specs call for a gap of 0.052-0.056. A while back I noticed a lack of smooth operation and missing in the engine, especially on the freeway at speeds of 55 mph. In a dark garage I noticed the spark-plug cables were arcing all over the place. I purchased from K-Mart and installed new silicone core suppressor spark plugs gapped at 0.045, but the cables are still arcing.

How can I get rid of this arcing? I'm sure it's robbing me of power and gas mileage.

A. M. Brouckaert, West Covina, Calif.

Move up to 8mm or 9mm premium-type plug wire or get a set of wire covers from Moroso Performance Products (737 Canal St., Stamford, Conn.). This problem has been around for some time. Latest cars have better wire and other necessary fixes. Problem in the high-energy ignition is that you get 30,000 volts and up, and it's very hard to totally contain. Some leakage is tolerable, since as a rule cars have nearly double the voltage they need. If yours is not missing, I doubt you're losing mileage and power. I agree I'd rather not have it leak; however, the biggest danger is not leaks but crossfire.

Wants to turbocharge

I am thinking of turbocharging a '76 Olds 350 with an Accel Turbosonic kit. I noticed the company limits the maximum boost on the kits with the optional boost control. How high could I safely adjust the boost? And for what horsepower?

Greg Moran, Walnut Creek, Calif.

Greg, when you want to spend some money and make life interesting, dabble in turbocharging. At low boost, six to seven pounds, you aren't as apt to get into trouble as at 12 to 20 or 30 pounds. Stick to specs given by experts or manufacturers.

The big problem with bolt-on turbo kits is fuel delivery. Everything else is easy. But the best U.S. fuel system I've seen is borderline for high-boost. Turbocharging power will nearly double for every 15 pounds of boost you put in. So will fuel requirements. Stay in low numbers and hope Buick gets its deal off the ground and that others follow.

Oil-consumption problem

In 1974 I purchased a new 454-cu.-in. Corvette and to date have driven it only 10,000 miles. It has always used oil at the rate of approximately one quart per 700 miles (10W-40 Valvoline). When I complain, the dealer and GM rep claim this is acceptable for big blocks. But I

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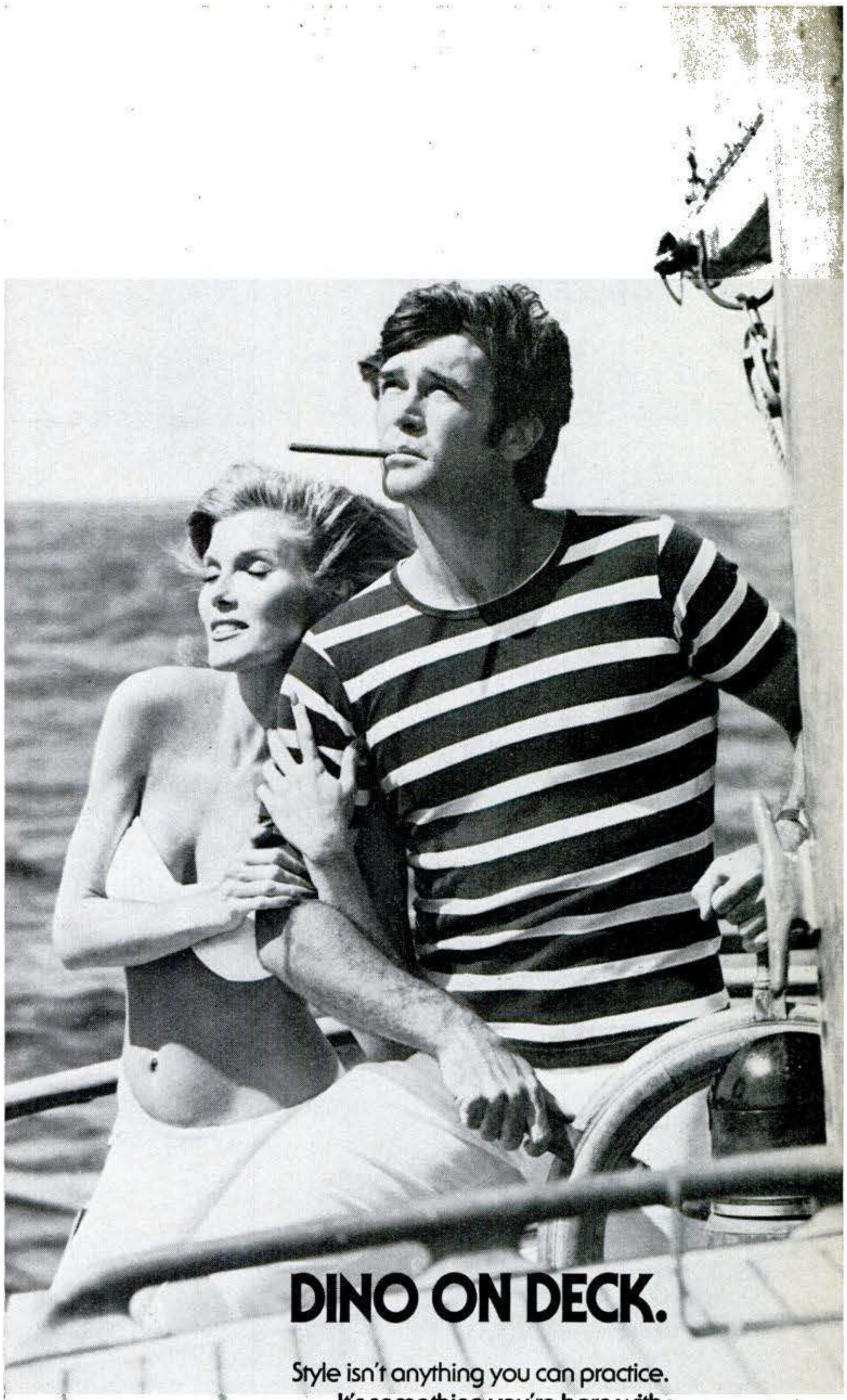

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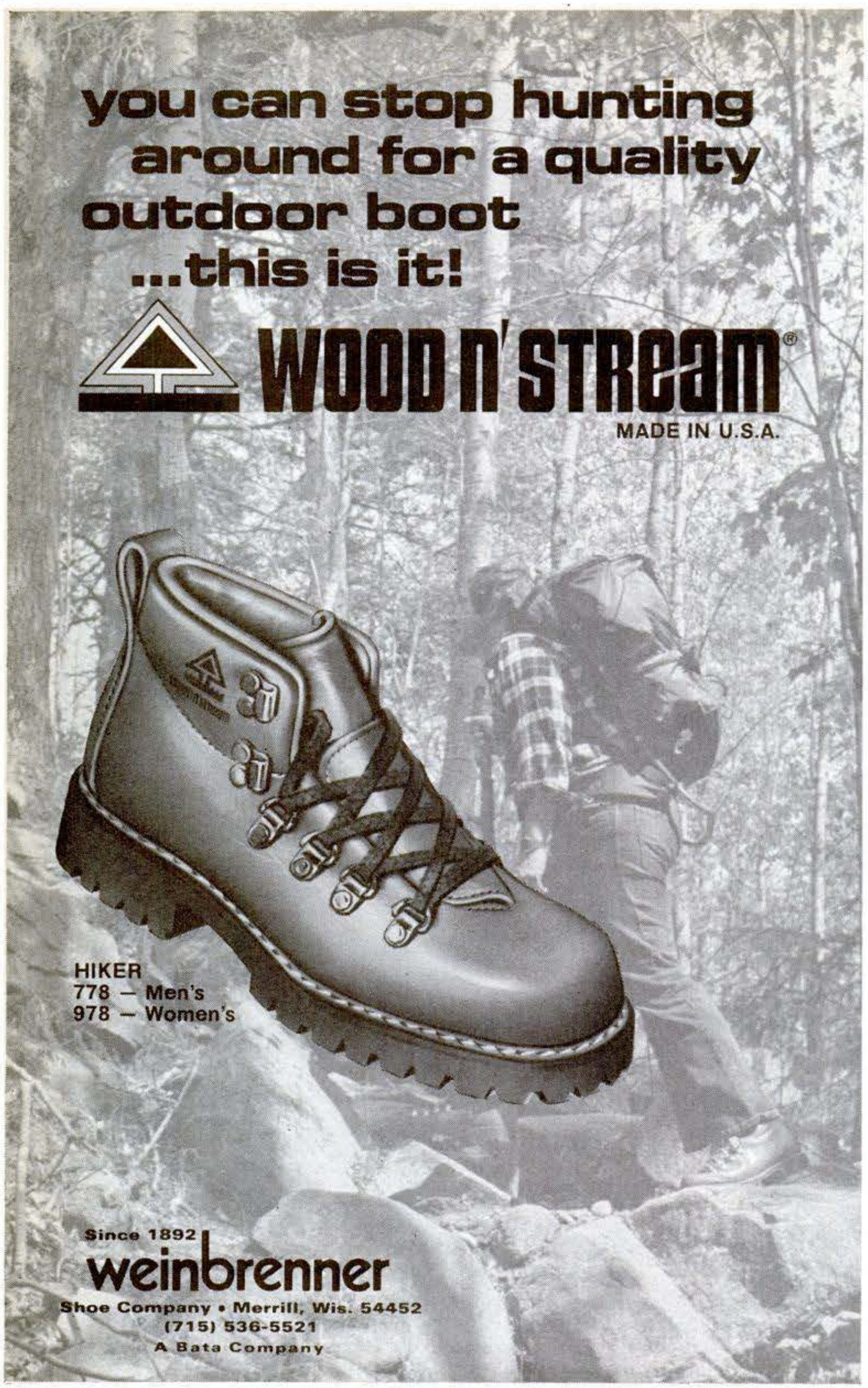

"Say, Smokey—"

[*Continued*]

have a 1975 Chrysler New Yorker with a 440-cu.-in. engine, which I drove from here to Vancouver last year (some 3000 miles) without consuming *any* oil. The GM rep's answer to this: They're not the same engines. I don't see any smoke from my car, and have had all the oil leaks corrected. Can you suggest anything? I would like to take a trip in my $10,000 car, but can't carry enough oil, as Valvoline is difficult to obtain at most service stations.

G. B. Whitaker, Toronto, Ont., Canada

Your oil consumption for that engine is bad, but from what I've seen not abnormal for that year and model engine. I can't agree that's the best it can do, but the fix will be expensive and may include reboring the cylinders, better piston rings, baffles in the oil pan, and valve-stem seal changes. Also, your crankcase venting may need changing to have a little pressure drop across it.

Got his money's worth

My 1972 Ambassador 360 V8 has 140,000-plus miles. For some time now it has required one and often two quarts of 10W-40 oil every 500 to 600 miles. Some time ago the valve seals were replaced. She trails no blue smoke, and apparently is not spewing it out the exhaust, for a friend followed me closely for more than 25 miles and noticed no smoke, no fine spray, no odor. There are no spots on the driveway, the car is relatively dry underneath, and the engine is fairly clean, considering age, mileage, etc. Any idea where all that oil can be going? Most of my driving is long-distance, top-speed, weekend travel.

C. Edward Graves, Randolph, Mass.

Your oil is burning nicely and is going out the tail pipe. You need a complete engine overhaul. Hell, it's time—140,000 miles is an impressive performance for any engine. When oil control is lost due to wear, it's possible to burn it without noticeable smoke except in high humidity. Matter of fact, I'd say you're the driver of the month. I'd like to start a 100,000-mile-engine club to give drivers like you some recognition, and to pass your tips on to less fortunate drivers.

Pre-ignition problem

I have one of the first 1976 Chrysler Cordoba lean-burn autos with a 400-cu.-in. engine equipped with a four-barrel carburetor. The car does not have a catalytic converter, and the recommended fuel is 87 octane regular.

The problem is a pre-ignition knock under certain conditions. When the engine is up to operating temperature and the cruise control is set (generally in the 50-55 mph range), a slight up or down grade causes a very audible rattle. Moving up to a 90-octane fuel reduces the knocking somewhat. I have 17,000

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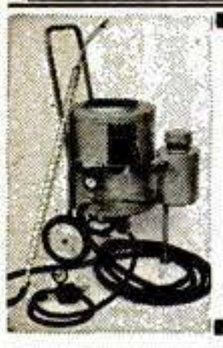

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"Say, Smokey—"

[*Continued*]

miles on the car. At the suggestion of the Chrysler factory rep I ran several cans of combustion cleaner through the gasoline tank—with no results.

Chrysler has a technical service bulletin, dated June 21, 1976, on the electronic-ignition malfunction problem, so there must be widespread difficulties in this area. Any suggestions?

Louis Courtot, Euclid, Ohio

I hear a lot of complaints like yours. Either fuel must be upgraded or timing retarded. It's just that simple. Now if higher octane fuel is unavailable or impractical, we are down to retarding timing. I realize this involves more than just loosening a bolt, but however it's done—electrically or mechanically—it must be done.

Your timing is so high that the engine is extremely sensitive to road load, barometric conditions, and fuel specs. From a timing standpoint, engines usually perform very well two or three degrees under maximum advance timing.

Lean burn apparently is going to need detonation sensors to retard the timing, which will keep the engine from pinging.

Wants more mpg

I drive a '76 Cutlass Supreme Olds, 350-hp engine. I drive defensively all the time. I get 15 mpg. What could I do to get 20 mpg?

Joseph Skiscim, Glendale, Ariz.

Joe, quit dreaming. A 350-hp engine and 20 mpg with '76 emission standards is hopeless, unless driven by a Mobil gas-economy professional. I'm serious. You're doing very well at 15 mpg. I'm talking tank mileage driven within reasonable limits.

If you can find a sharp, interested mechanic who has $75,000 worth of tools and gauges, he can get you more mileage, but at a higher cost per mile than you're paying now.

Engine dies turning left

Nobody seems to understand this at all: My '74 Duster dies every time I go into a left turn—and only a left turn—hard. If I go straight or turn right, it operates fine. What's wrong?

Phillip Maston, Los Angeles, Calif.

Float position—fuel level in the float bowl. Go look at it; think about where the fuel goes in a left-hand turn and what's happening to the jets and the fuel bowl.

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—" Popular Science, 380 Madison Ave., New York 10017. Questions cannot be answered by mail.

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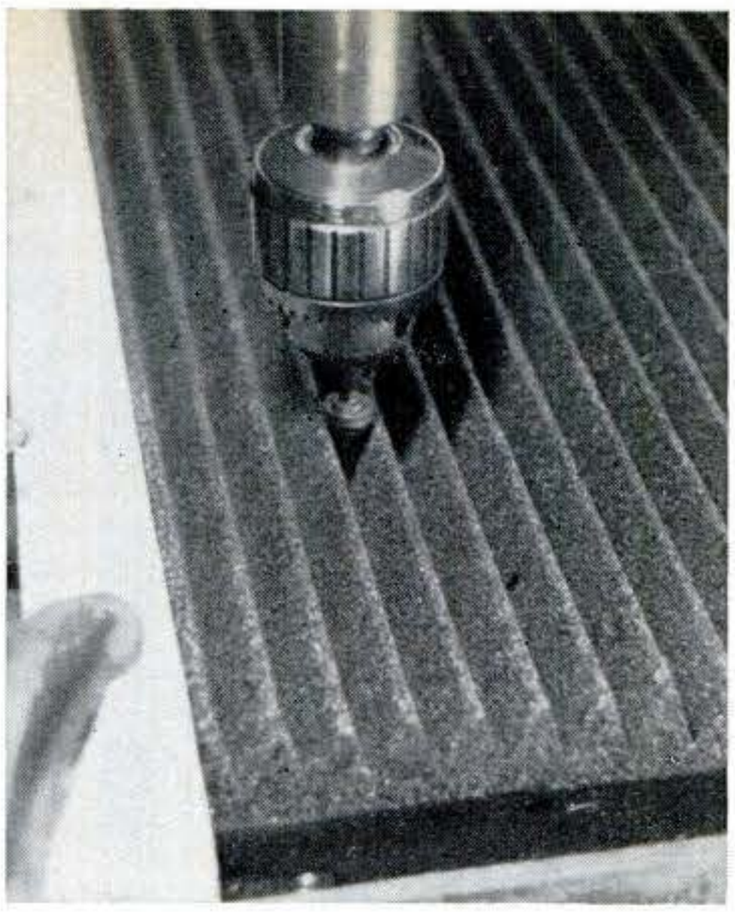
Test stand (at West Virginia U.) has three collectors: liquid-type reference panel at left and two air-type Foamglas units at right.



A conical spindle in a drill press cuts Foamglas quickly. V grooves at 30 degrees were chosen for optimum absorption of diffuse and direct radiation.

Solar collector for 85¢ a sq. ft.

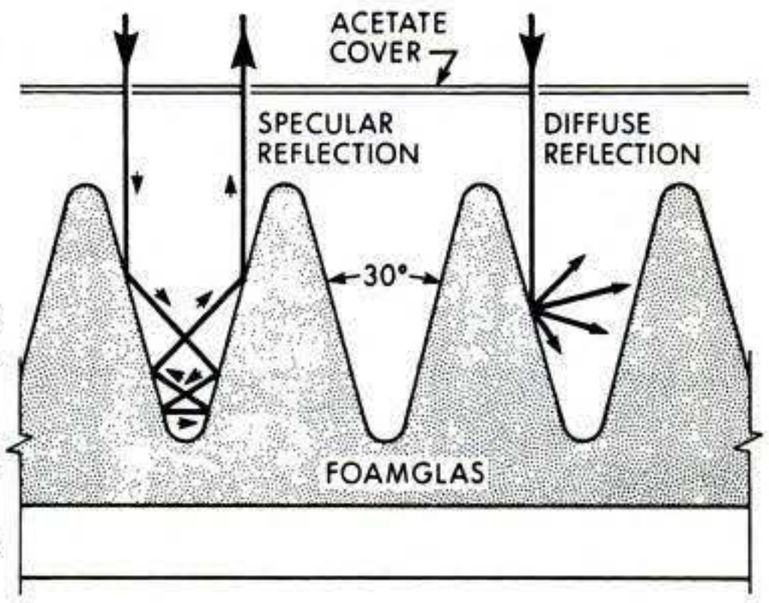
A single material in this ingenious solar collector performs three functions:

- It absorbs solar radiation (see drawing at right).
- It serves as the collector's finned heat-transfer surface.
- It provides adequate thermal insulation.

The air-type collector was developed by Professor John L. Loth of West Virginia University in Morgantown. The triple-threat material in Professor Loth's collector is Foamglas, a rigid foam in which V grooves have been cut. It's sold in 1½"-thick slabs by Pittsburgh Corning Corp. (One Gateway Center, Pittsburgh, Pa. 15222) for 35 cents a sq. ft. The only other material used in the collector is the glazing: 0.040"-thick Kal-Lite fiberglass, made by Kalwall Corp. (Box 237, Manchester, N.H. 03105). It costs 50 cents a sq. ft.

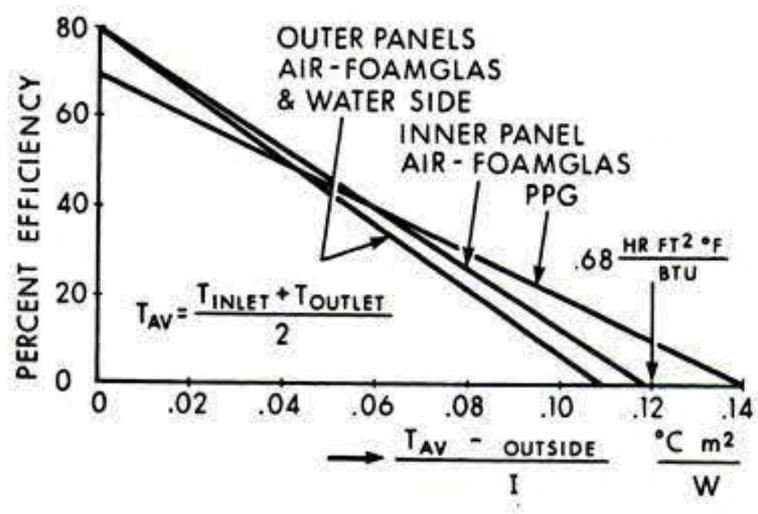
Professor Loth chose Foamglas for several reasons. It can withstand temperatures up to 800 degrees F, and it isn't harmed by being spray-painted flat black. Furthermore, the V grooves are relatively easy to cut in the Foamglas slab, and many air pockets are exposed in the cutting process. These air pockets increase the convective heat transfer between absorber surface and air, and also produce more diffuse reflection than specular reflection of solar radiation (see drawing).

An installation could be simple, says Loth: "The grooved Foamglas



can be glued directly to shingles, and the transparent cover can be stapled over it. Air could be ducted in and out through holes cut in the roof at the east and west ends of the horizontal grooves."

Loth cites yet another advantage of the collector: "It can start collecting heat within five to 10 minutes after exposure to the sun." That's because the Foamglas has a lower thermal capacity than collectors with metal absorber plates. The latter often require 20 minutes or more warm-up time. This gives the Foamglas collector greater heat-collecting capacity on days with intermittent sunshine, says Loth.—*R. L. Stepler*



Efficiency curves are shown for three collectors on WVU test stand, as well as curve for PPG liquid-type collector. Foamglas collectors compare favorably.

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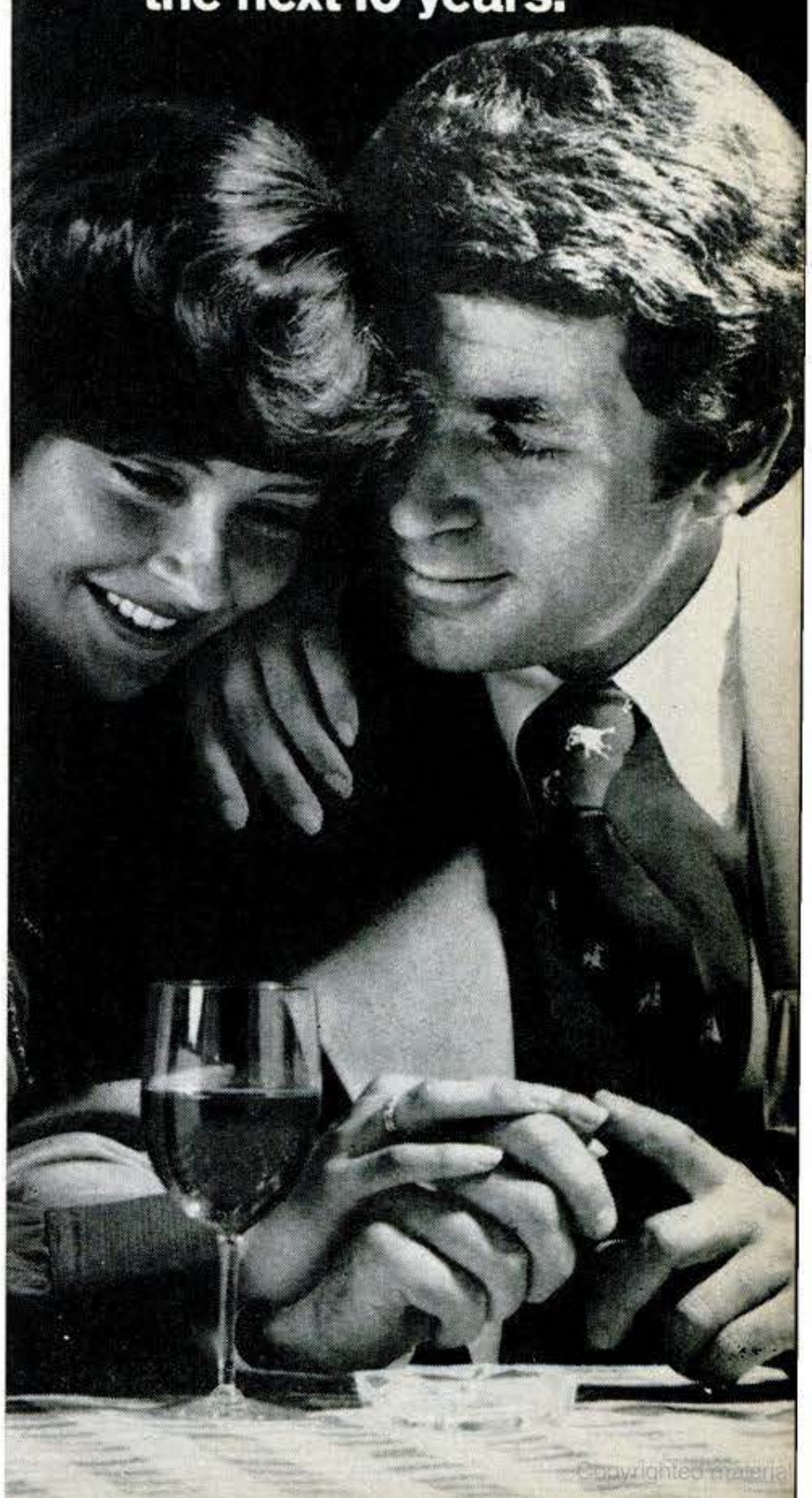
Do something about the next 10 years.



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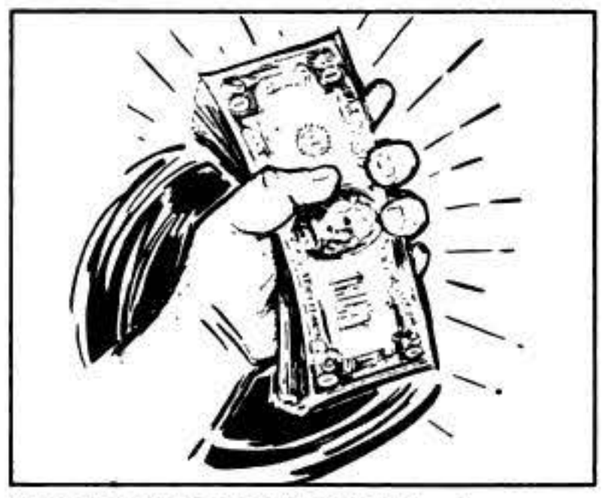

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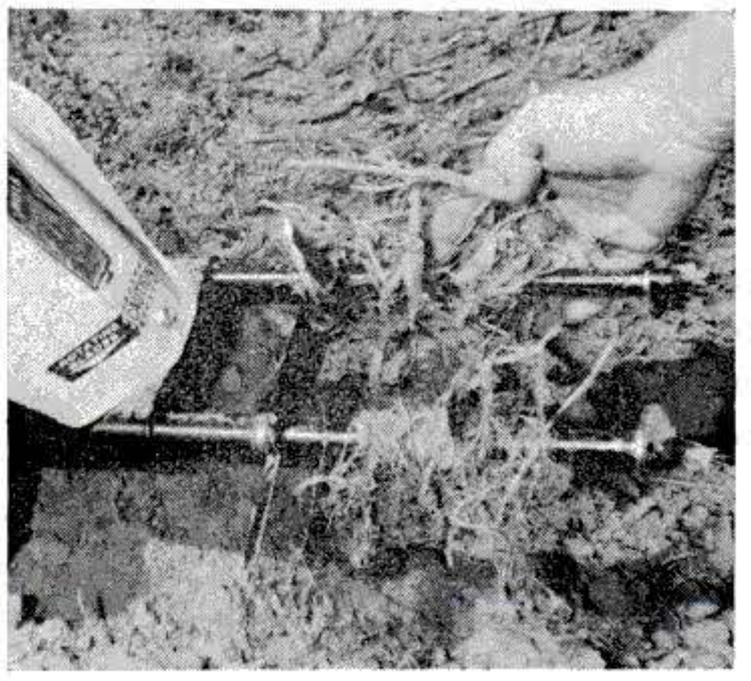
Versatile new garden tool: Soil digger-mixer

I'm not overly friendly with muscle-powered spades, so I looked at the 115V, all-electric Garden Maid soil blender with some doubt. But that was before I actually got a chance to stick its two counter-rotating augers (below) into the soil.

I found that by aiming the augers down at a steep angle and then pulling back on the handle I could effortlessly penetrate and break up sod and hard ground. Working the tool along at a flatter angle tills and breaks up the soil, mixes in fertilizer, develops hilled contours, and snatches out weed roots. Pointing it straight down burrows out a perfect cavity for tree or bush planting.

Although much more powerful than you'd guess, the soil blender is not intended for working up huge gardens. The Garden Maid weighs 33 pounds; its motor is a ¾-hp with speed from 0-125 rpm (varied by fingertip control). It costs about $130. Detroit Tool (Box 232, Lebanon, Mo. 65536) makes it.—*E. F. Lindsley*



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Who says you have to spend a small fortune for a beautiful shade tree — and then spend half a lifetime waiting for it to grow? That's the way it used to be — BUT NOT ANY LONGER! Not since we've finally tracked down the one single tree in all of nature that hoists itself so high, so fast you can literally measure its incredible rate of growth week by week . . . or for even more dramatic proof, take a yardstick and measure the difference in feet month to month!

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SPECTACULAR BEAUTY ALL 4 SEASONS OF THE YEAR!

Yes, here is one of those rare gifts of nature that not only thrusts itself to towering heights in record time . . . that not only drapes itself in lush green foliage from Easter time to way past Labor Day . . . but for a real "magazine cover effect" lavishes its branches with delicate clusters of beautiful, flowers starting in spring . . . and then in fall and early winter for a real show-stopper transforms its colors to a golden pyramid and in the dead of winter its graceful branches make a startling contrast against a snow-covered landscape! Meaning: you get a spectacular show of changing beauty ALL 4 SEASONS OF THE YEAR!

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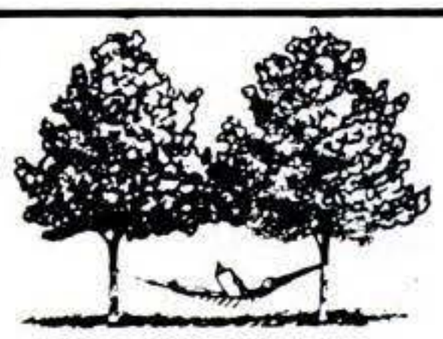
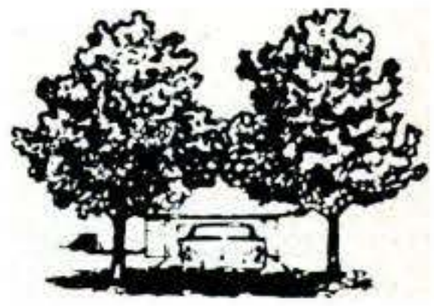


Here's a luxury sight you don't have to wait half a lifetime growing — a matched pair of showpieces, so strong and sturdy you can actually sling a hammock between them.

Picture your patio bathed in the cool, fragrant beauty of this show-stopping miracle-tree from early spring to the first snows of winter.



How's this for a natural archway in front of your driveway—twin towers of beauty in less time than you ever dreamed possible.

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Water-based Aquasol has nonflammable spray. Precision Valve president Abplanalp tests spray on candle's flame: It was promptly extinguished.

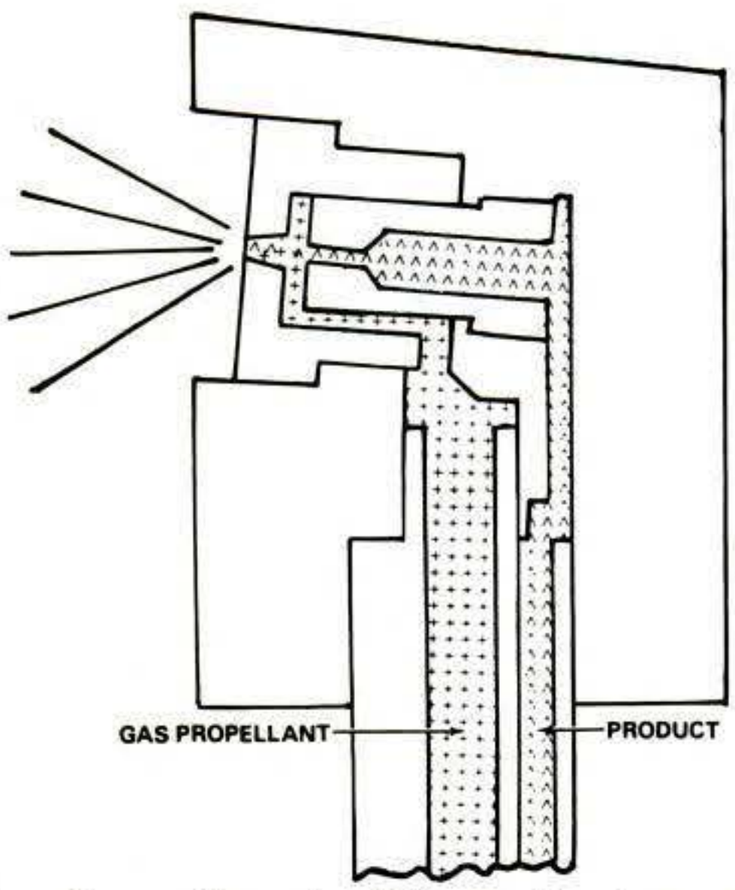
Aquasol
aerosol spray without fluorocarbons

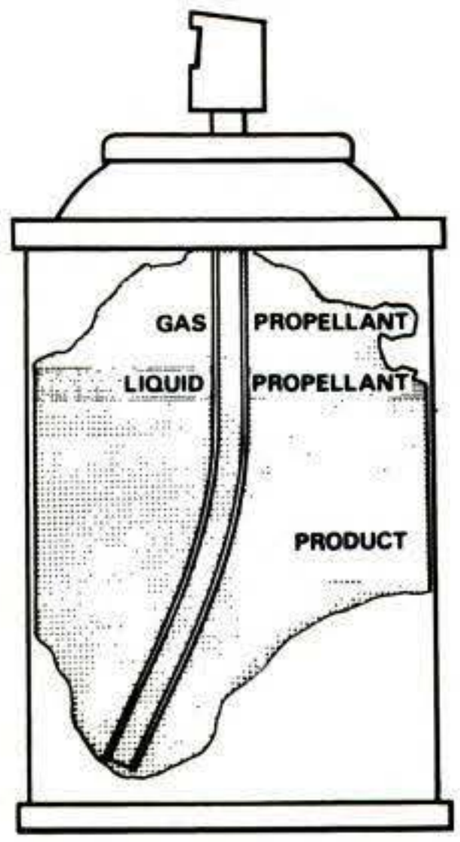
With federal regulations on fluorocarbon sprays in the offing, inventors are finding ways to rescue Americans from an aerosol-less society. Robert Abplanalp, inventor of the valve that made lightweight spray cans possible, and president of Precision Valve Corp., Yonkers, N.Y., has announced a new aerosol system that uses no fluorocarbons and thus poses no threat to the ozone layer.

Dubbed Aquasol, the system uses hydrocarbons—isobutane, butane, or propane—as the propellants. What makes it possible is a unique valve (see drawing). And, says Abplanalp, "while Aquasol was perhaps developed in response to [government] regulation, this is one of the few times that consumers won't have to foot the bill."

That's because, claims Abplanalp, Aquasol doesn't need as much propellant as present aerosols: Aquasol's product-to-propellant ratio is 6:1 vs. a conventional aerosol's 1:1.

When will you see Aquasol sprays on the shelves? Early '78 is Abplanalp's estimate.—*R. L. Stepler*





How Aquasol works: When valve button is depressed, pressure forces the product into valve via tube that extends to container's bottom. Simultaneously, gas propellant moves into valve via separate channel in valve at top of container. Product and gas meet in venturi chamber, and gas propellant, under high velocity, breaks up product stream into tiny particles and forces it out in a uniform, fine spray that is indistinguishable from conventional aerosols.

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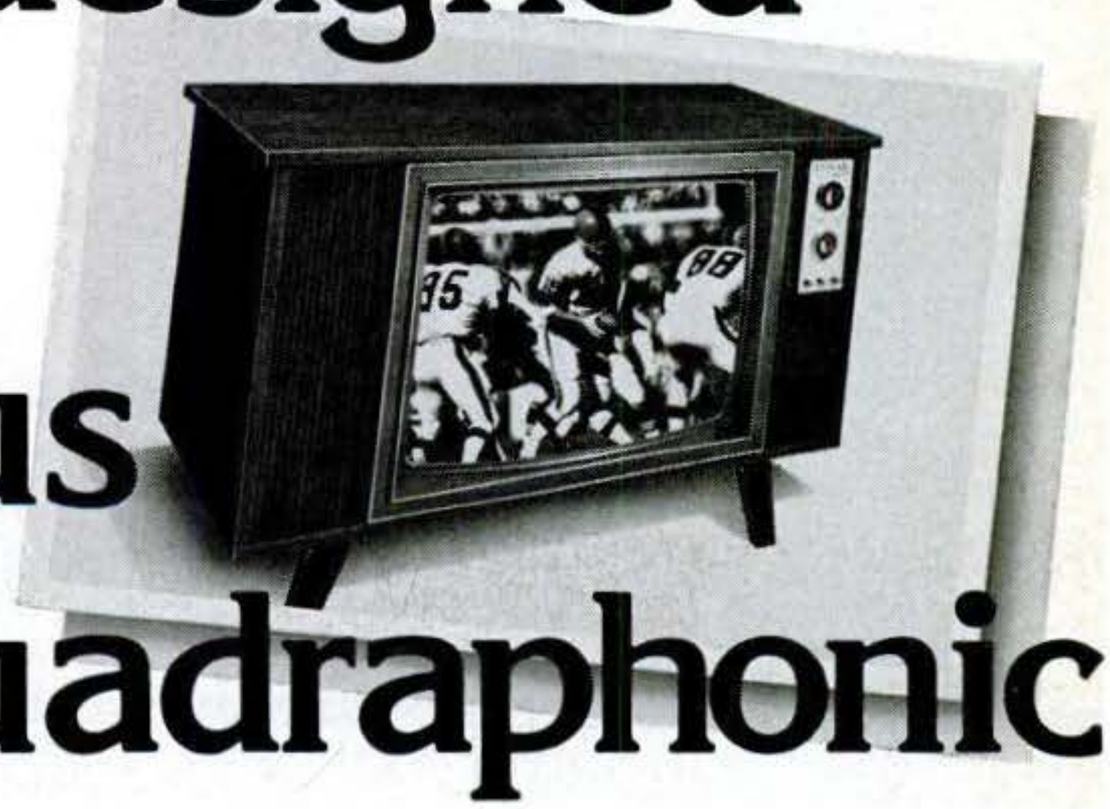

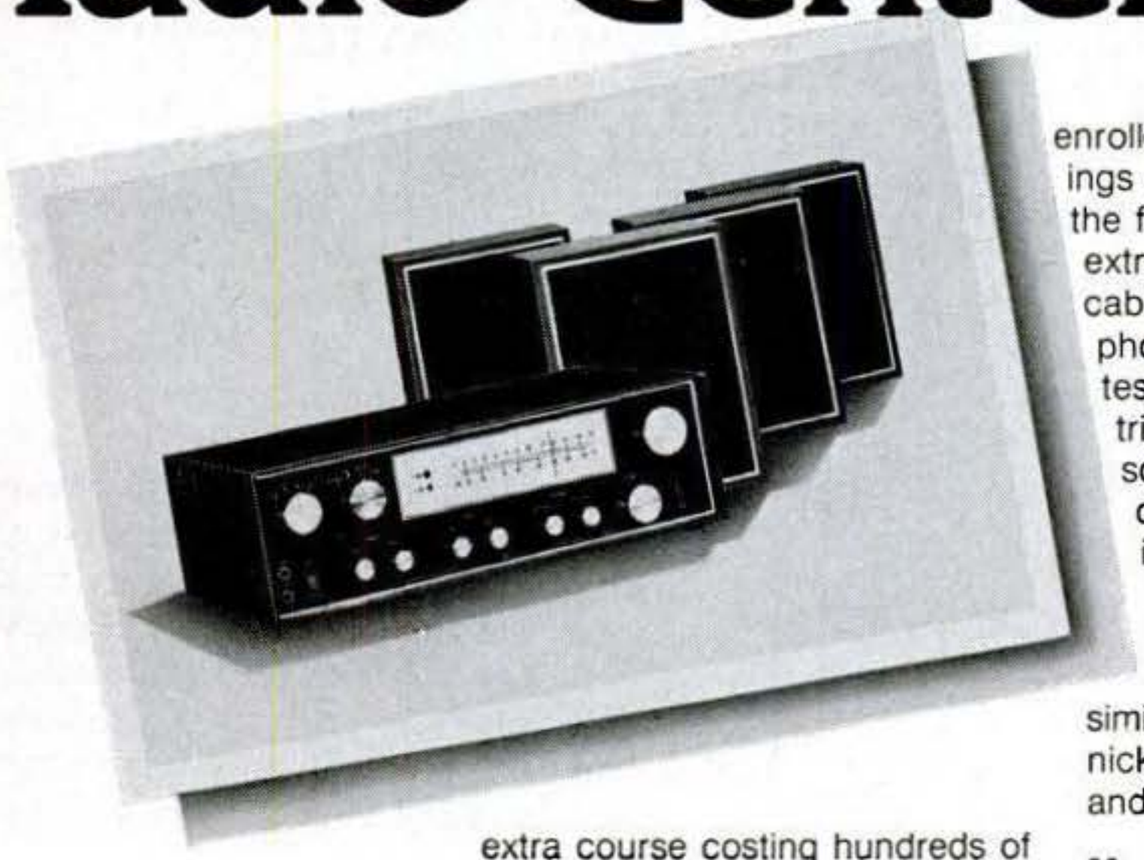

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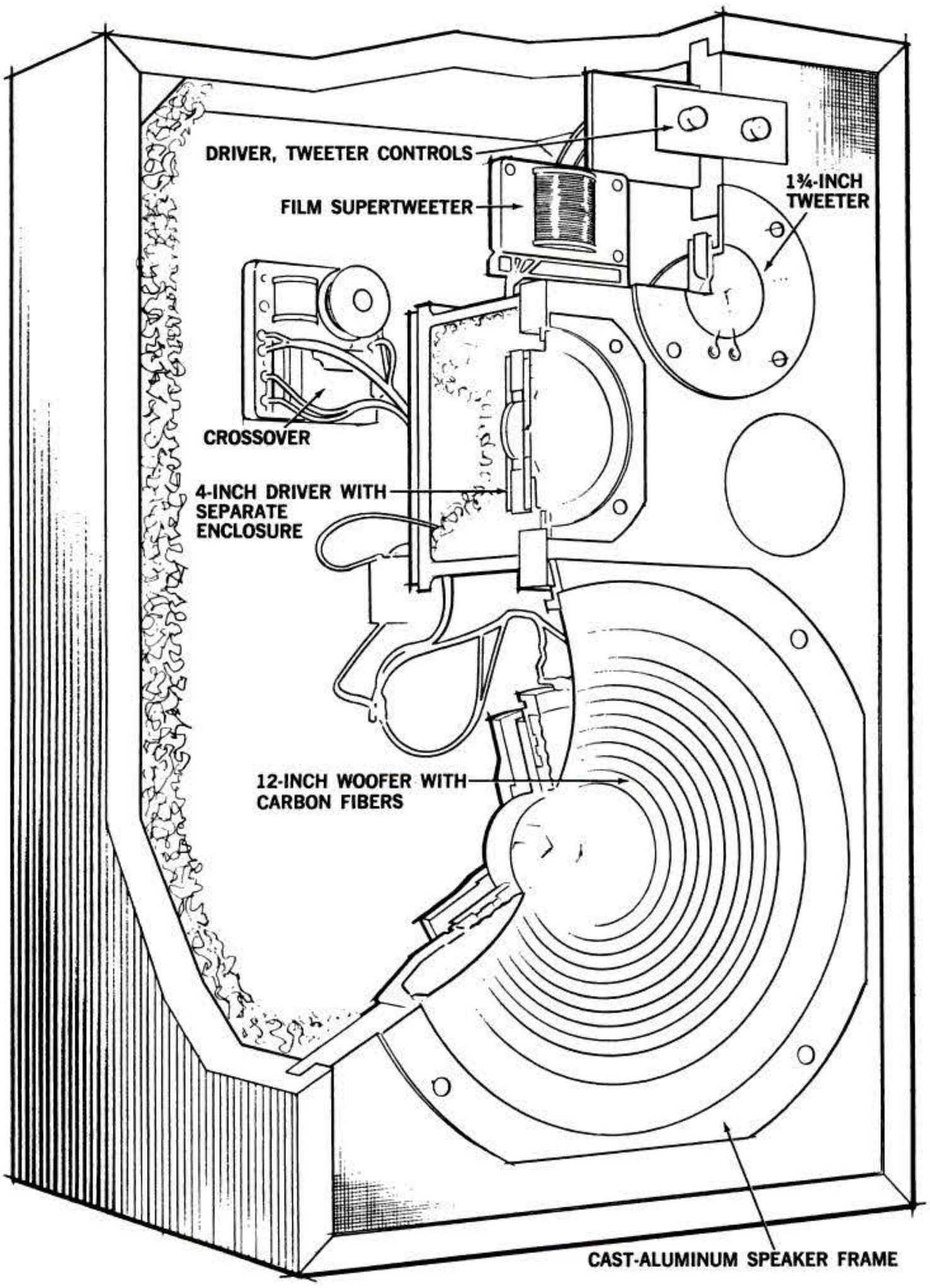
They're still inventing **hi-fi loudspeakers**



Basic elements of a modern speaker appear in cutaway of Pioneer's HPM-100. Film tweeter for uppermost highs (see text) can be seen near the top.

New speakers are making waves with brilliantly ingenious designs

By HANS FANTEL

Loudspeaker designers have been relaxing for years, resting on a basic formula. All of them made "bookshelf" speakers—airtight boxes packed with conventional woofers and tweeters. But lately, some radically different designs have been making waves. In short, they're still inventing loudspeakers.

These innovations aim at any or all of three goals: better highs, wider sound spread, and greater efficiency—more sound per watt.

The push for new speaker designs is largely a result of improvements in other branches of audio. Phono cartridges, amplifiers, and—above all—recordings now put out a wider range of sound with less distortion than just a few years back. Challenged by these developments, speaker designers have had to find ways to do justice to those new highs in audio signals. And different companies have gone different ways to attain smooth, peak-free response to the outermost limit of human hearing. Take Yamaha's beryllium tweeter dome, for example. Or Pioneer's pulsating film.

The key to better highs lies in making tweeter diaphragms capable of wiggling back and forth up to 20,000 times per second. What's more, each swing must push enough air (that is, travel a sufficient distance) to create realistic loudness levels. The result is tremendous mechanical stress with

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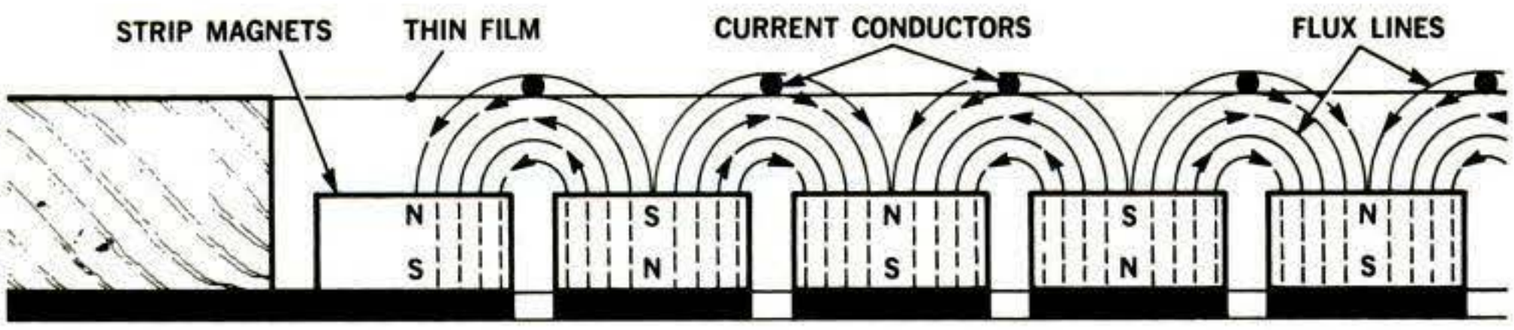
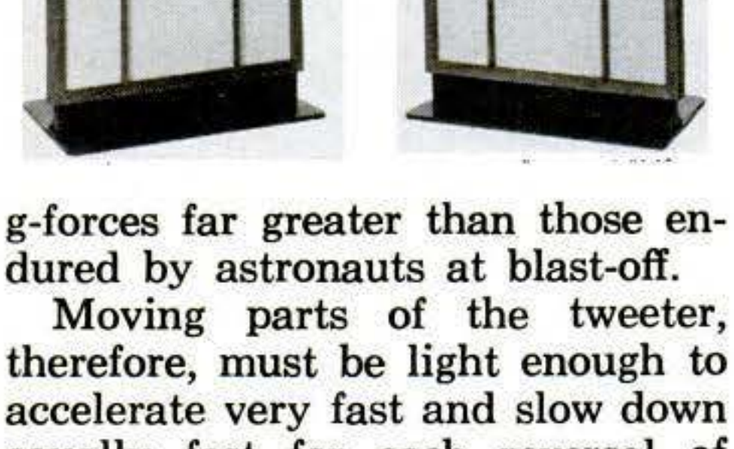




Flat plastic panels of Magneplanar speakers have current-conducting flat wires (the "voice coils") attached to them in a zigzag pattern. Audio signals flowing through conductors interact with field from strip magnets, moving the plastic film. Sound radiates from both sides of the loudspeaker panels.

g-forces far greater than those endured by astronauts at blast-off.

Moving parts of the tweeter, therefore, must be light enough to accelerate very fast and slow down equally fast for each reversal of motion. Extra weight adds inertia, making the moving part of a tweeter too slow on the uptake and prone to overshoot its mark. If this happens, the sound generated by the motion no longer corresponds exactly to the signal from the amplifier. The result is distortion.

But lightness isn't enough. A tweeter diaphragm must also be so rigid that it pushes the air like a solid piston. If it buckles under stress, the musical waveform gets mangled.

To meet these conflicting requirements, Yamaha developed a tweeter dome made of beryllium, which has the most favorable weight-strength ratio of any known metal; it is half as heavy and four times as rigid as aluminum. Japanese engineers claim that the moving part of the tweeter used in Yamaha's NS-1000 and NS-500 (priced at $980 and $500 per pair) is "about half the weight of one petal of a small sweetheart rose." I rarely get all that poetic, but I was impressed with the clear sound and the fact that the moving mass of the beryllium tweeter is only 0.03 grams (compared with the one-gram moving mass that's usual for a tweeter of the same size).

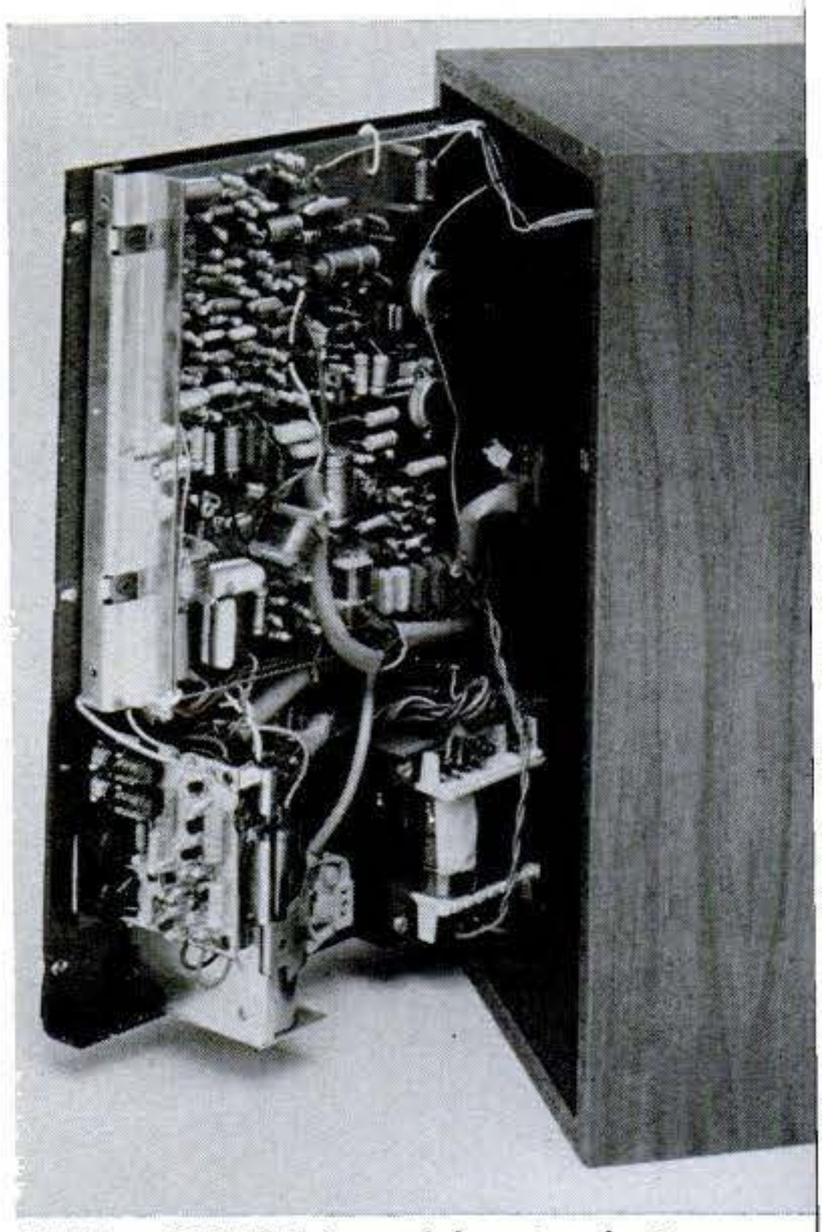
Pioneer took another tack to achieve minimum mass by doing away with the conventional coil-and-magnet structure that moves the tweeter cone. Pioneer's unique high-frequency sound source consists merely of a polyvinyl film coated with an ultrathin aluminum layer. The molecules in the plastic are so polarized that they move in response to an electric voltage. When the audio signal is applied directly to the aluminum layer, electromotive forces are generated and the film pulsates in step with the signal. Since the motion originates all along the surface of the film, no force needs to be transmitted from one location to another and no stiffness is required. And since there are no other moving parts to add inertia, the result is a highly accurate treble, scattering broadly from the whole film surface.

I listened to this tweeter in Pioneer's new HPM-40 and liked its clarity and punch. With a hefty bass and smooth midrange to match, this speaker is a sound buy at $150. The same tweeter is also used in bigger and costlier models of Pioneer's HPM series.

All these new tweeters reach way up to 20,000 Hz and beyond—past the upper limit of human hearing. But frequency measurements don't tell the whole story.

"Response curves just don't always correlate with the subjectively experienced sound character of a speaker," says Stewart Hegeman, a veteran designer of top-rank loudspeakers.

Many speaker makers agree. Feeling that frequency-response curves are rarely informative and often misinterpreted, most companies won't publish them. Their specs give only upper and lower



Philips RH535 has elaborate electronics and separate amps for woofer and tweeter. A feedback control circuit ensures that cone motion conforms to signal waveforms.

response limits, and maybe the maximum deviation within that range, indicated by ±dB. And that tells you next to nothing. In fact, two speakers with nearly identical "paper specs" may sound altogether different. That's why critical listening comparisons are a better guide than figures.

The hot pursuit of better highs led to other unconventional tweeters (see diagrams) with extreme frequency ranges that rival any dog whistle. Each has its own sonic flavor, but their similarities are more striking than their differences. I've checked out the lot of them and—as a group—they all deliver a bright, zingy treble that puts real zest in the music. You can practically see the gleam of the brass and feel the stick hit the drumskin.

But these speakers can also be cruel. They'll show up every speck of dust on your discs and every flaw in the rest of your rig. On older records with traces of wear or built-in distortion, you'll have to nudge down the treble control to keep these super-critical speakers from sounding harsh.

The extended frequency range now available has made both listeners and engineers more aware of the importance of a broad sound

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Unyielding traffic barriers cause highway deaths they were meant to prevent.

Every year, nearly 7,000 people die when their cars collide with fixed roadside hazards – unyielding objects like bridge abutments, signs or median barrier ends. Many are killed or injured by rigid guard rails which were meant as protective devices.

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A life-saving shock absorber

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Hi-fi loudspeakers

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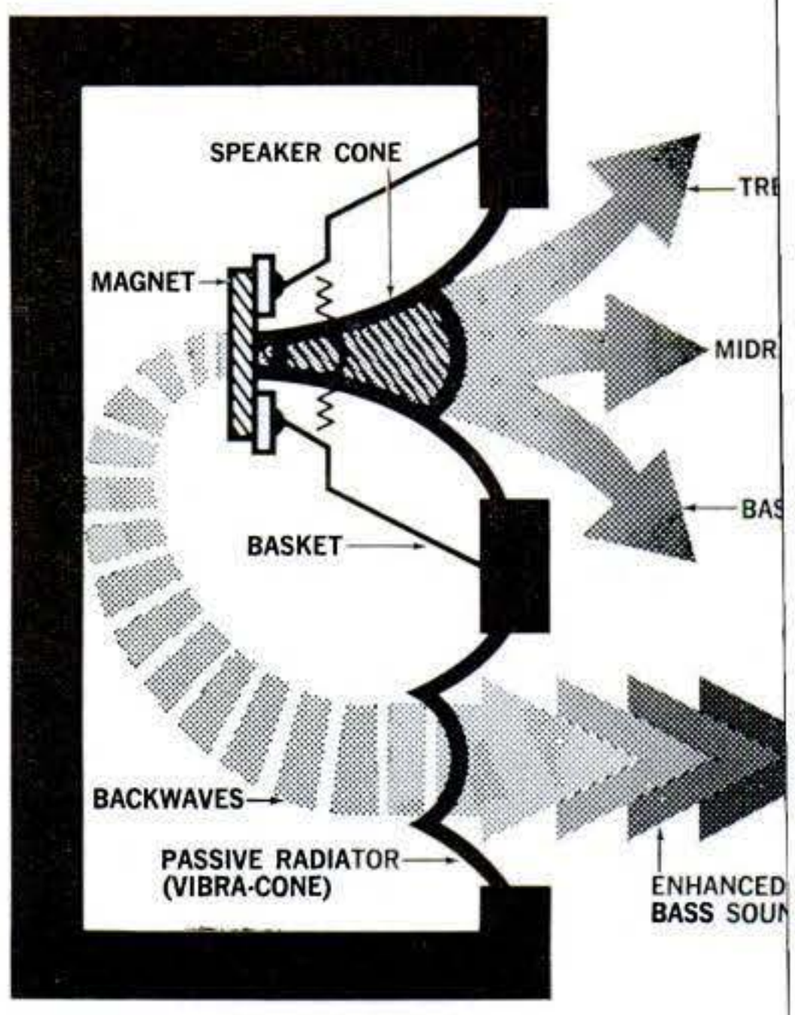

Passive-radiator drone cone covers bass port in some speakers. Back pressure from woofer motion provides extra radiation surface to aid bass projection.

spread. It is no longer enough just to get the sound out of the box. Realism also depends on a "space effect" produced by sound reflections in the listening room. Some of the new speakers maximize this effect by scattering the sound so that it bounces off the walls and the ceiling. A highly unusual speaker of this kind was designed by Dr. Amar Bose, a professor of electrical engineering at the Massachusetts Institute of Technology.

"In 'live' listening," explains John Wawzonek of Bose Corporation, "more than 80 percent of the total sound energy reaches the ear by way of wall reflections—like a

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POPULAR SCIENCE

"I would have been a famous missile scientist today except for my inability to count backwards."

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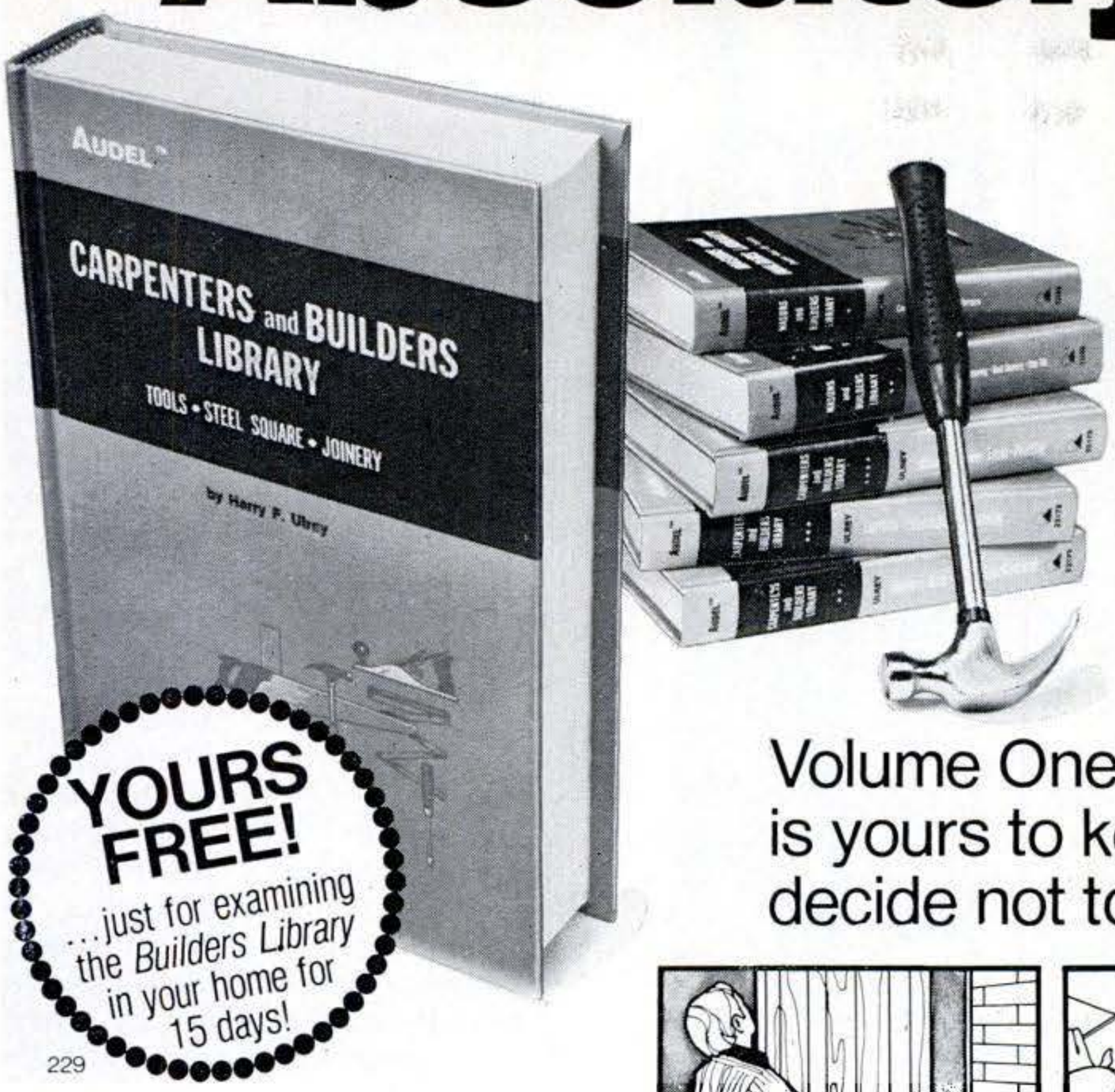

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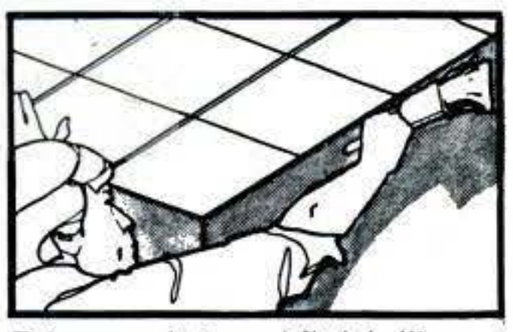
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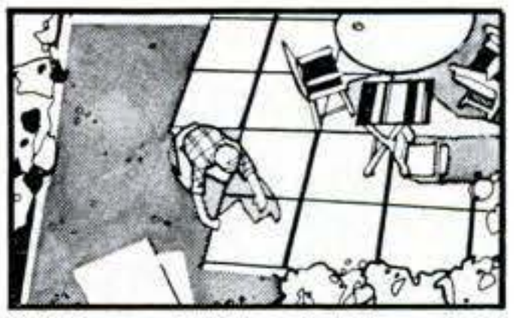
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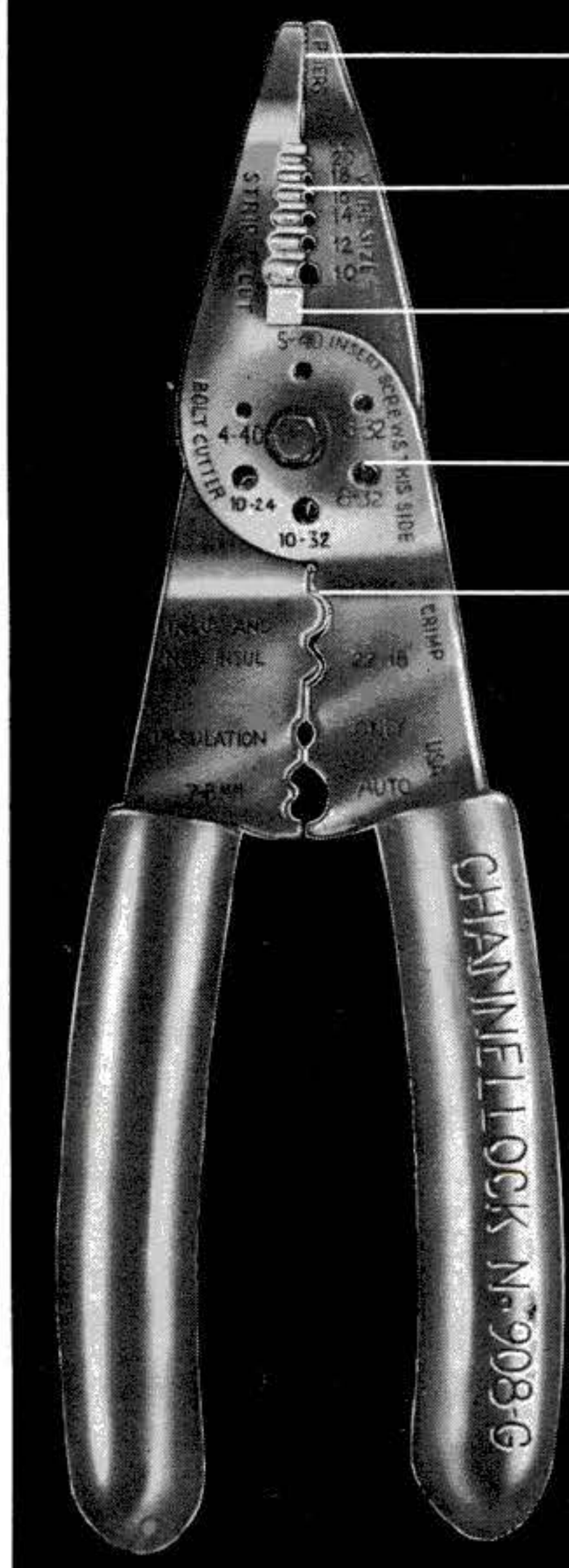

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Hi-fi loudspeakers

[*Continued*]

carom shot bouncing off the edge of the pool table before hitting the pocket."

To duplicate this pattern, the new Bose 901 Series III radiates most of its sound output *away* from the listener toward the rear and the sides of the room. Where the sound hits the walls, it reflects as from a mirror, playing very pleasant tricks on your ears. Just as when you look in a mirror, your reflection appears *behind* the mirror, the sound reflections make the music seem to be coming from *behind* the walls. The net effect is an impression of sitting in a large concert hall even when you're listening in a small room.

The Bose 901 is unconventional in other ways, too. There are no woofers and tweeters. The sound is generated by a total of nine identical four-inch speakers, each separately chambered within an odd-angled enclosure. A special electronic equalizer creates the desired full-range response by shaping the amplifier signal to fit the speaker's response curve.

"Most speaker designers try to get flat response by stretching the capabilities of the speaker materials," Wawzonek says. "We think it's easier to compensate electronically for the mechanical properties of the speaker. We push the signal in those parts of the frequency spectrum where the speaker is naturally weak, and we weaken the signal where the speaker is naturally efficient."

In the Bose plant in Framingham, Mass., just outside of Boston, I had a chance to see the company's computerized quality-control system, which is partly responsible for the success of this design. At the end of the line where the cone drivers are assembled, a test signal "sweeps" each speaker through the entire frequency range.

The computer "listens" through a calibrated microphone, checking the output of a frequency analyzer. If any driver deviates by more than a preset tolerance from the desired curve, the computer automatically rejects it. At the same time, it prints out a diagnostic report, showing where the faulty speaker went off limits and by how much.

"This automated analysis," says Wawzonek, "ensures that every element in the nine-speaker array is

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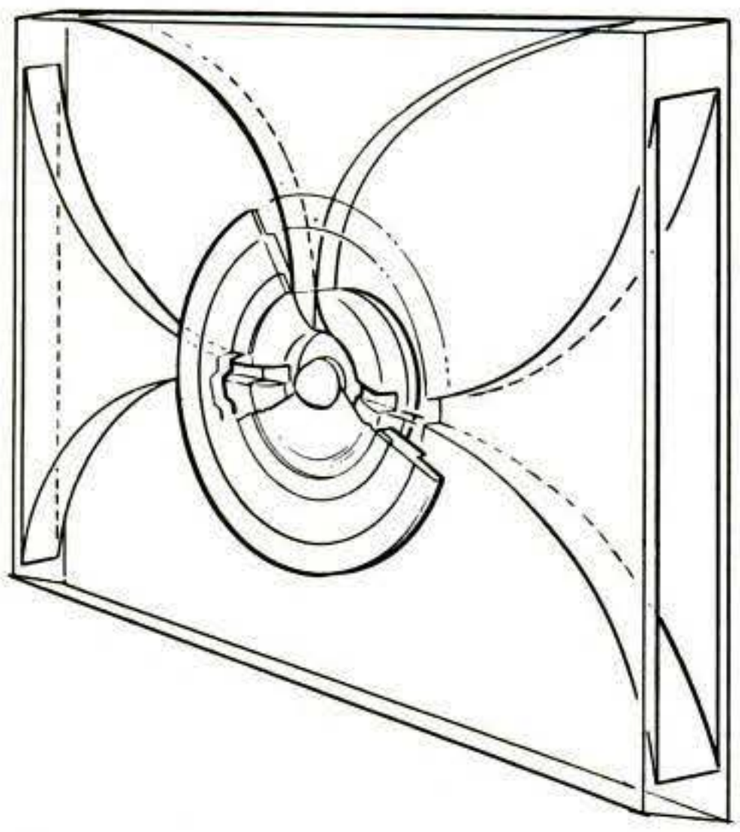
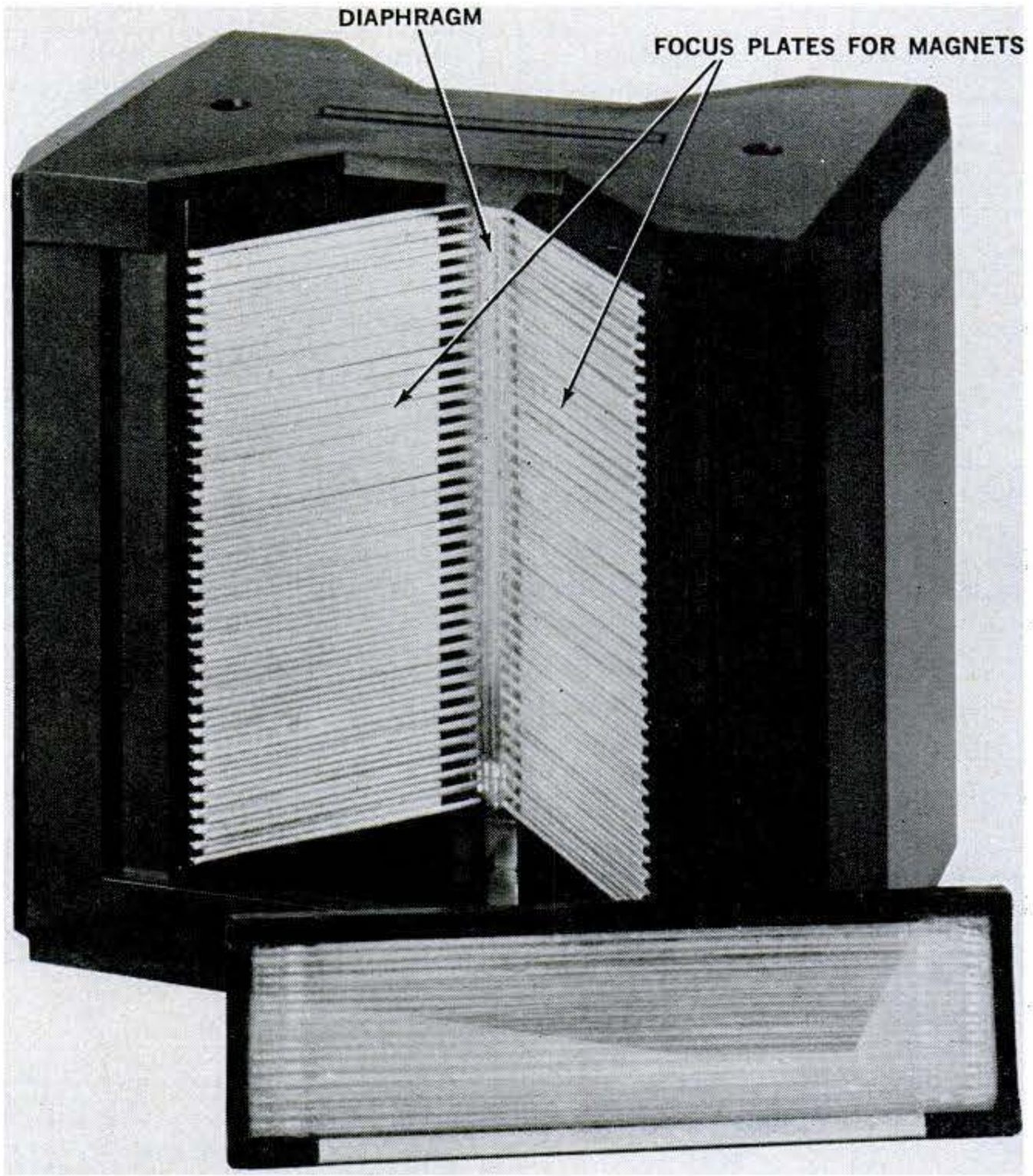
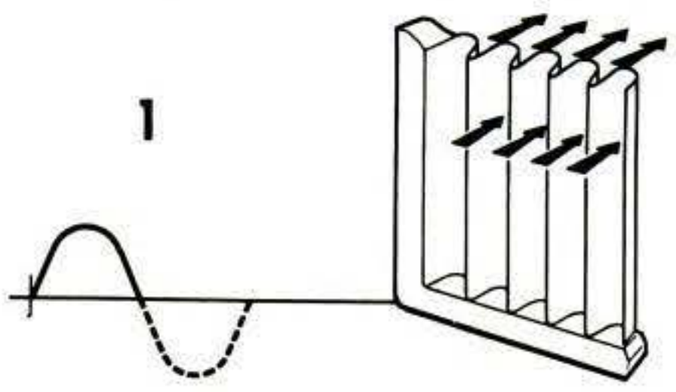


Horn-shaped ducts behind forward-facing tweeter in Sansui's LM speakers project rear radiation from the tweeter cone sideways as well as upward.





Accordion-like pleats in ESS's Heil air-motion-transformer tweeter squeeze together and pull apart, drawing in air from one side of diaphragm and radiating it from the other during positive signal cycle (1); directions reverse during negative cycle (2). Signals flow through conductors on pleats.

up to specs and compatible with every other driver."

I wondered about two nozzles sticking out in back of the 901, looking like the tail end of a DC-10. Those are actually air jets, Wawzonek told me, to relieve the back pressure generated by the pumping action of the nine cones. Feeling the air flow, I held a match to one of the nozzles. It blew out when the music hit a low note.

By reducing back pressure, the vents let the cones make wider swings, pumping out more sound per watt of applied power. This makes the speaker more efficient than an earlier version using a sealed enclosure. In the new model, 20 watts per channel suffice to produce thunderous sound levels, and since the resonant frequency of the vents lies *below* the audible spectrum, there is no false bass boom. The speakers sell for $700 a pair. I haven't heard more spacious or better balanced sound at any price.

A few designers go even further to create a three-dimensional sound field. They aim sound at the ceiling as well as the walls, adding a vertical component to the reflection pattern. For example, Hegeman's H-1AW ($450 per pair) scatters sound in a hemispheric pattern—upward and all around—as does the Design Acoustics D-2 ($300 per pair). In each case, the dome-shaped radiation pattern is produced by an upward-angled tweeter. The vertical sound throw gave me a unique feeling of being immersed in the music. In fact, just two of these upward-facing speakers in standard stereo reminded me of the kind of sonic ambience you normally achieve only with four-channel sound.

Another recent design trend centers on new ways to get more bass with less power. This means a possible swing from the airtight box that has long been used for speakers operating on the air-suspension principle. These sealed enclosures produce clean bass, free of boom and false resonance. But they are inefficient; that is, they gobble up lots of watts to reach high loudness levels.

To get more volume from lower-powered (and therefore cheaper) amplifiers and receivers, speaker designers have now developed another approach. Instead of trapping the back pressure from the moving speaker cones inside the sealed enclosure, they make this previously wasted energy audible through vents. Unlike the vents in the Bose, these openings are tuned *within* the audible spectrum. The gain in efficiency is so great that some recent models pump out room-filling

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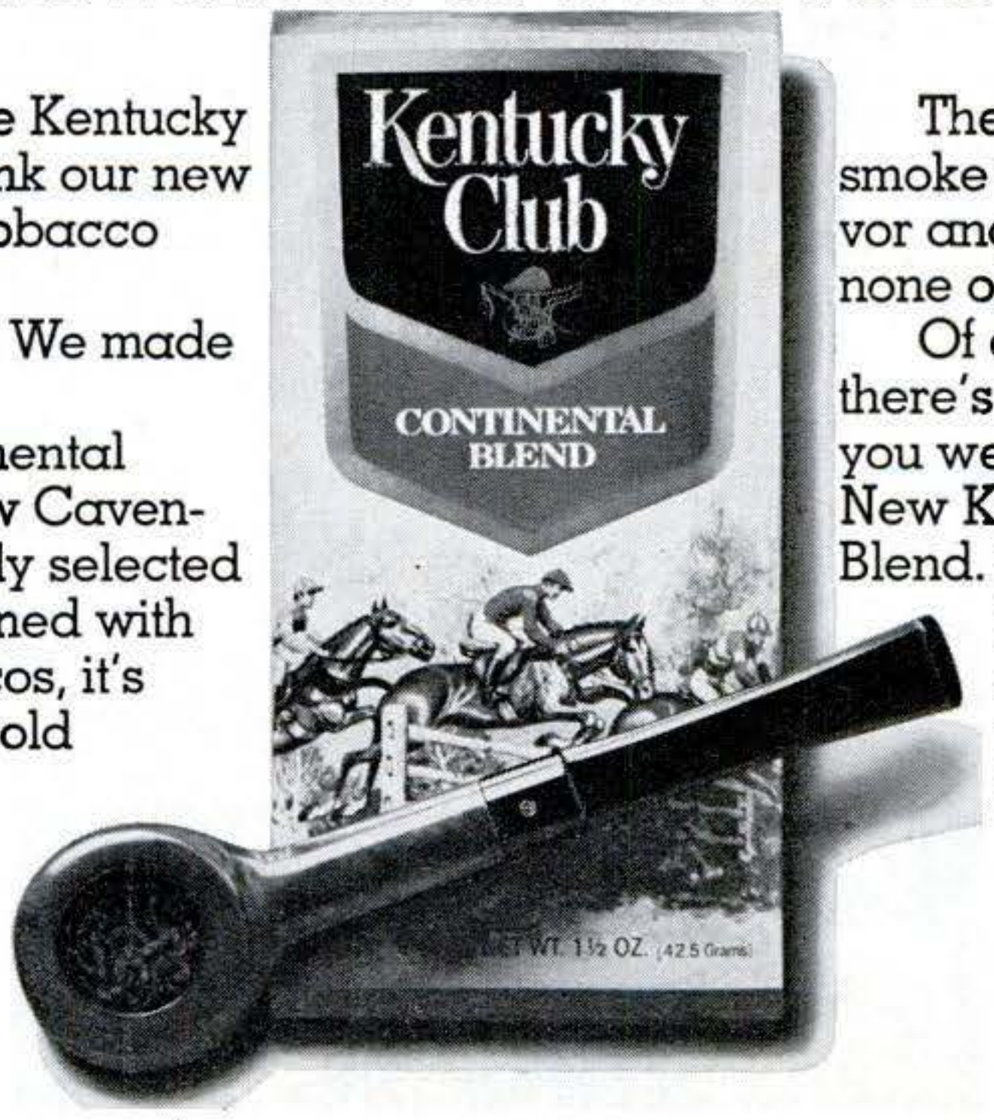

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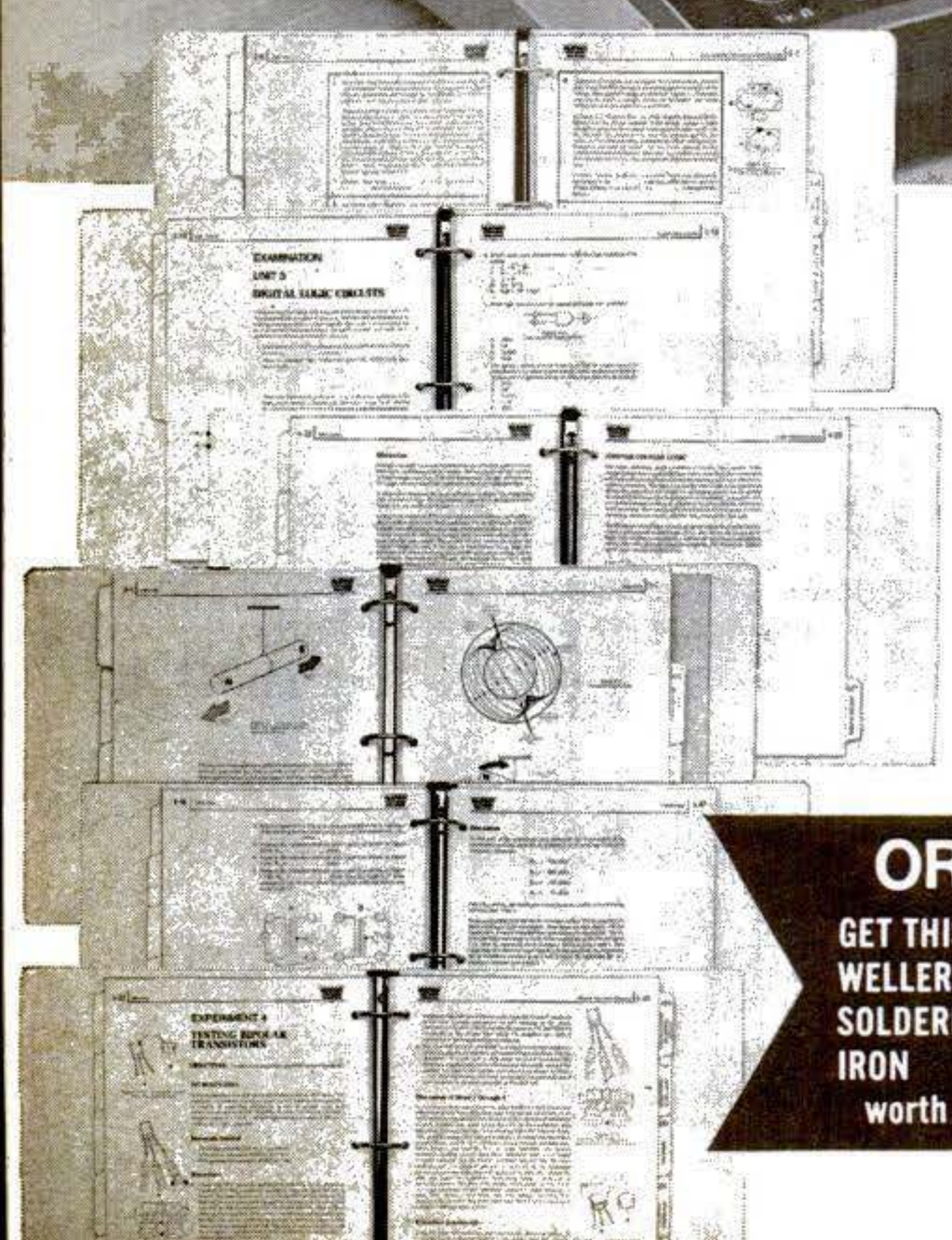

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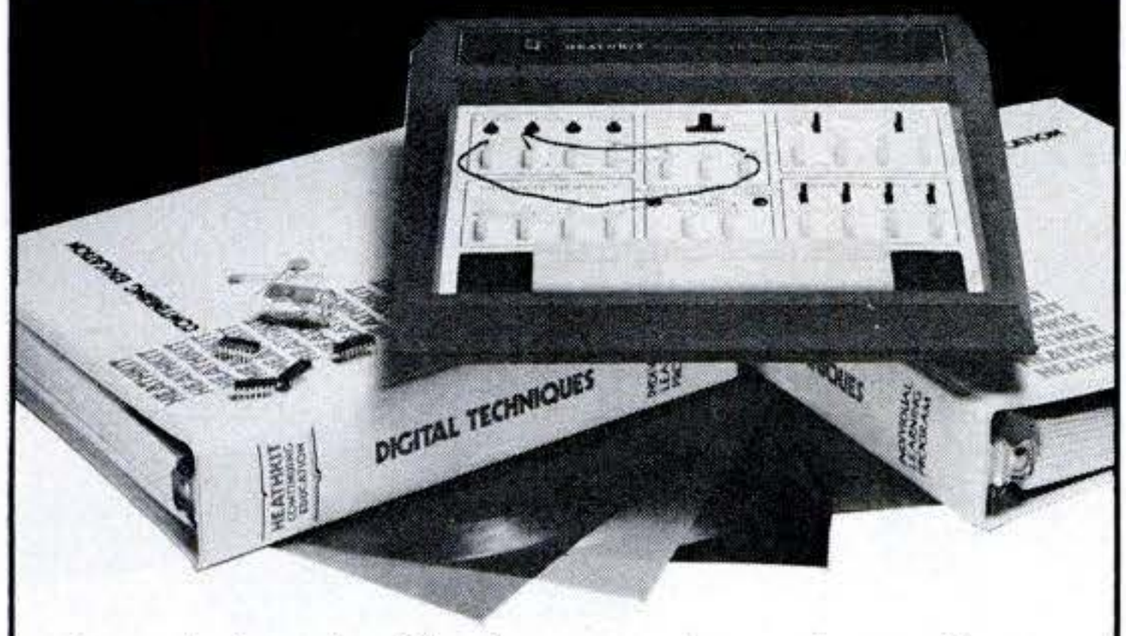

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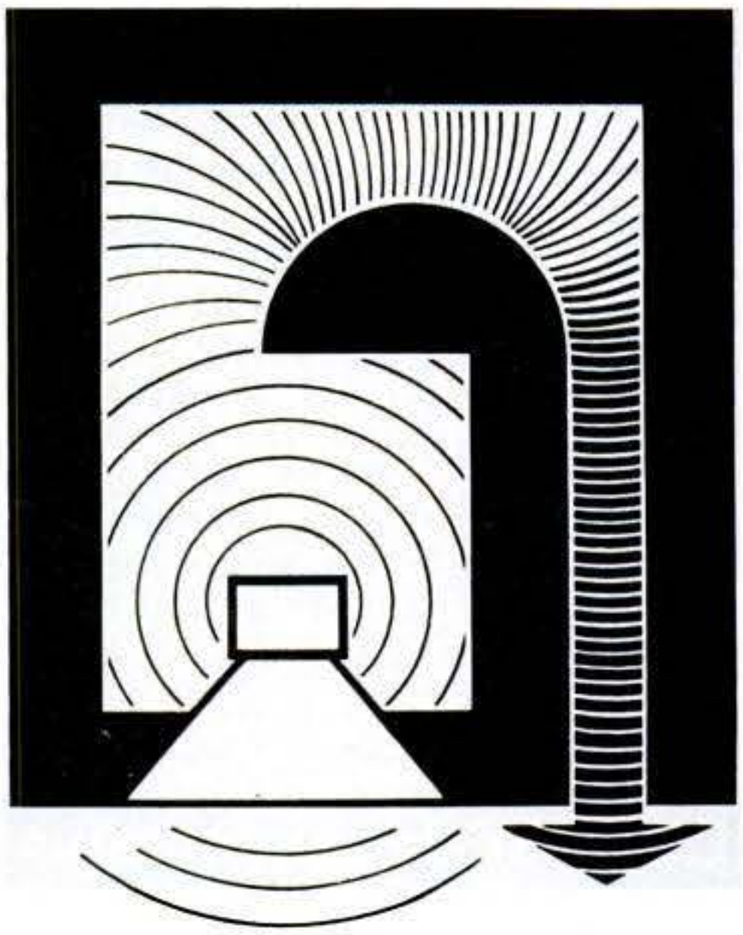

Vented enclosures have been improved as in this B.I.C.-Venturi design. Chamber behind the woofer leads into a tapered duct that compresses and accelerates air from back on cone. Rear energy from speaker emerges in phase with frontal sound, reinforcing bass.

Single driver of dunce-cap-like Ohm F speaker is made largely of titanium foil for stiffness. Magnetic driver at top activates upper portion of cone to produce hemispheric treble pattern; lower part of the cone projects bass into a vented enclosure.

sound from as little as 10 watts of amplifier power per channel.

The idea of vented enclosures isn't really new; it dates back to the bass-reflex baffles from the early days of audio. However, those bass-reflex speakers of yesteryear sounded boomy and hollow—like talking into a barrel—because they added their own resonance to music.

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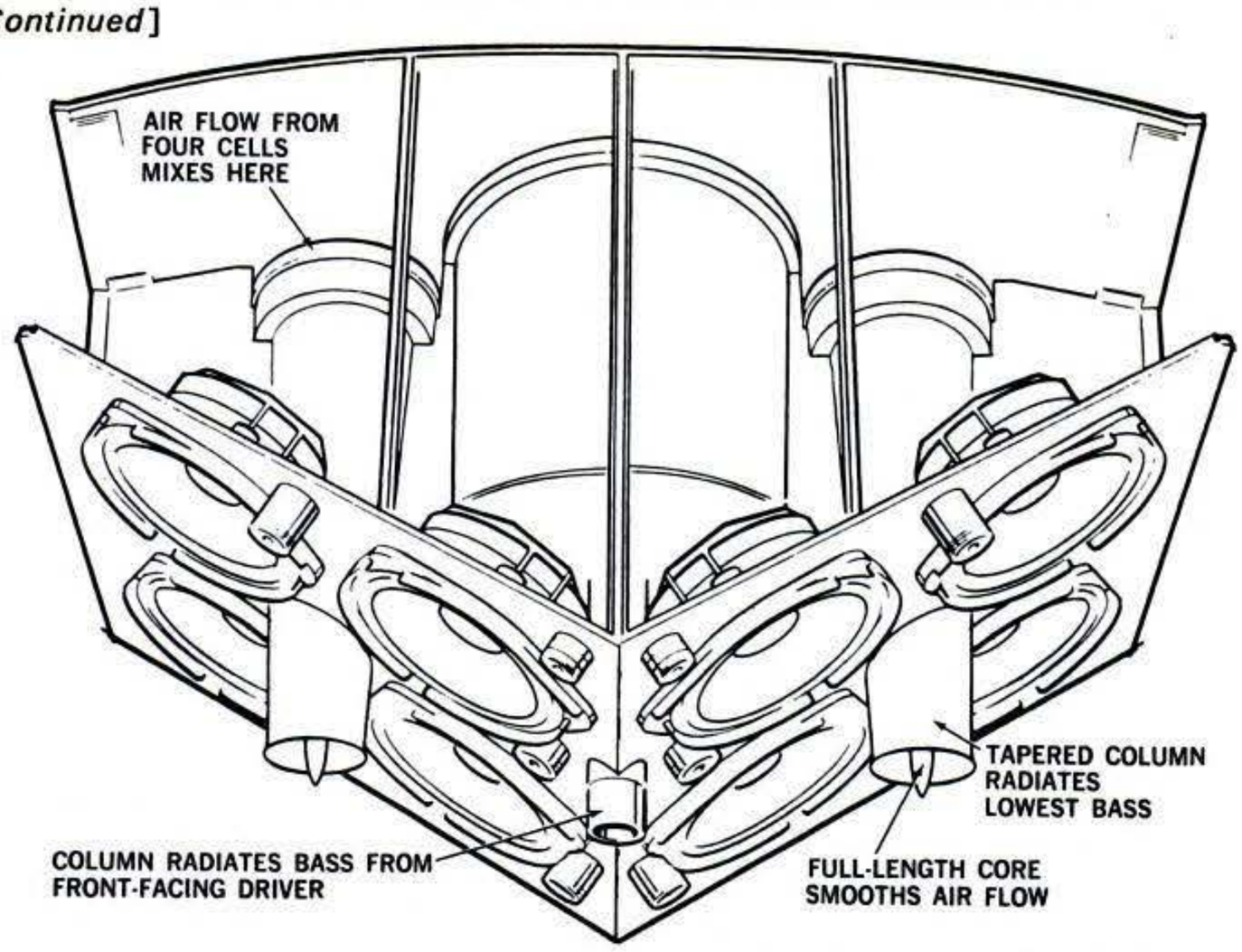

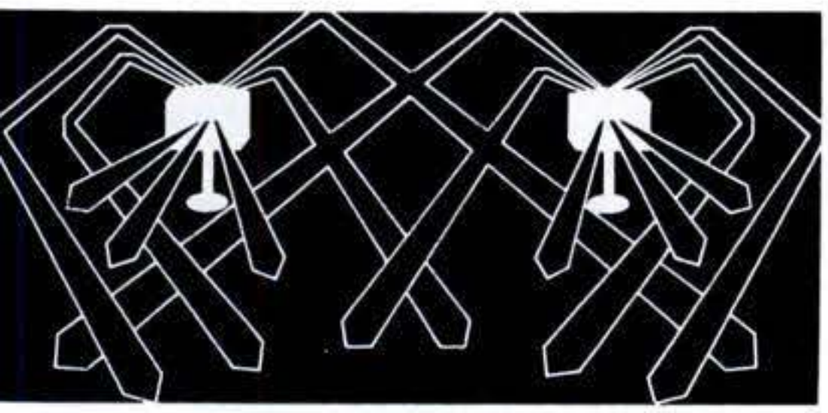

Rear panel of Bose 901 Series III has eight drivers (ninth speaker points forward). Sound is widely dispersed by reflections (left). An electronic signal processor varies input signals to compensate for four-inch diameter of speakers. Speakers are mounted in semi-isolated cells. Three reactive air columns improve low-frequency cone motion for better efficiency.

In their new form, vented speakers have largely overcome this drawback. The vent now usually takes the shape of a flared duct with dimensions carefully calculated to suppress unwanted resonances. Computers now whiz through complex design formulas, analyzing the interaction of woofer cone, enclosure volume, duct shape, and vent area. With the help of such sophisticated design aids, engineers almost succeeded in eating their cake and having it, too—the designs combine high efficiency and clean bass.

To evaluate these enclosures, I asked to see the impedance curves that show the resonance of a speaker system. Invariably I was told that these curves—like other electrical measurements—don't really jibe with the acoustic result. So again I had to rely on my ears.

In side-by-side comparisons, I found that the vented designs get pretty close to the sealed boxes—though it would be exaggerated to claim that they are quite as clean

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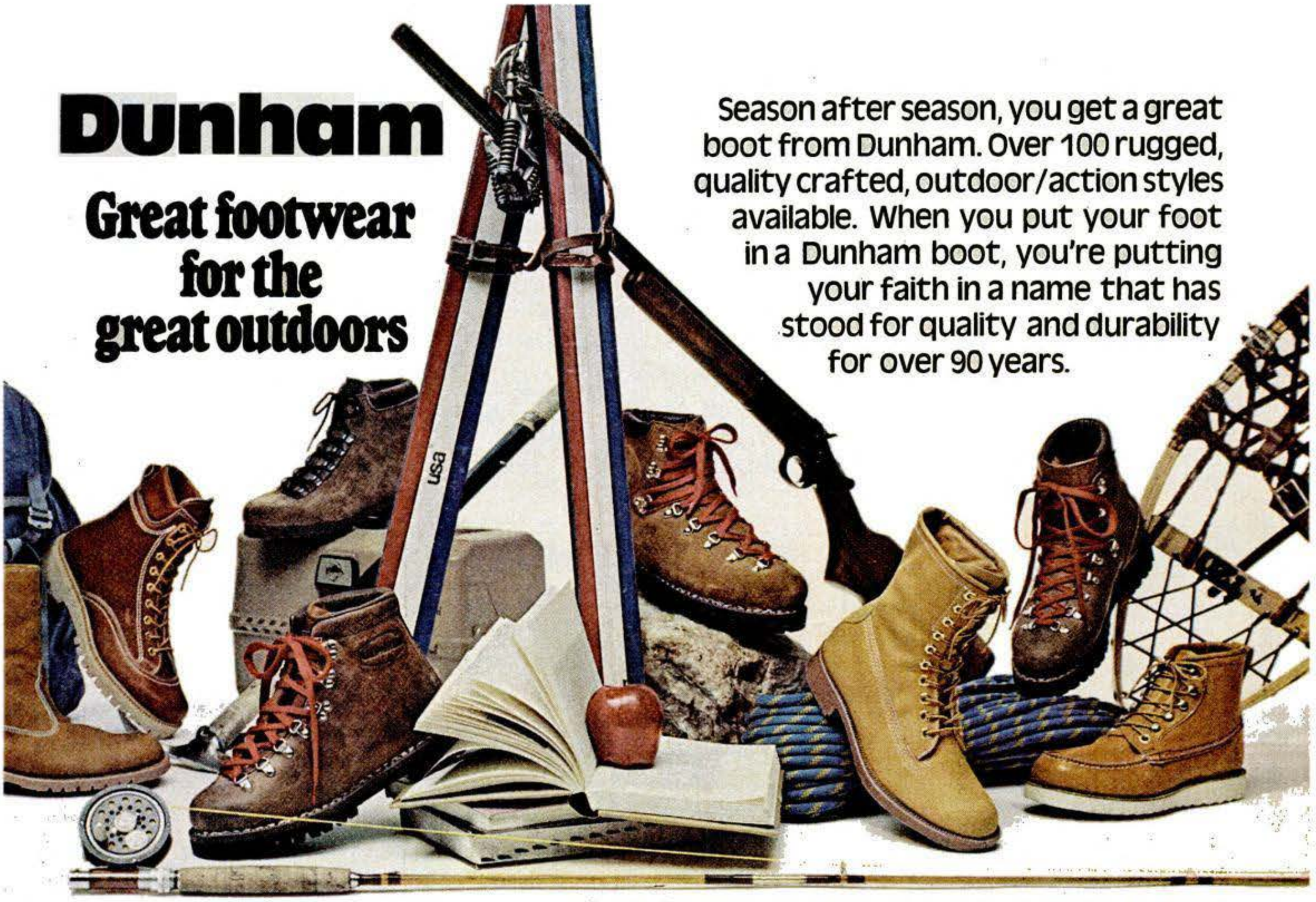

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Minicomputer monitors home electricity use

On a searing hot summer day, which would bother you more—to have your air conditioner automatically shut off for seven minutes every half-hour—or to have it conk out for five hours because of a blackout?

If your local utility company adopts a system developed by American Science and Engineering Inc. (955 Massachusetts Ave., Cambridge, Mass. 02139), you'll have the first option. The system, called ASEP, lets utilities regulate power use to prevent blackouts.

The system also offers automatic meter reading, giving utilities another tool to even out power consumption. Twice-daily meter reading means that utilities can set higher rates for peak hours. Such multirate metering should encourage off-hour use of major appliances.

The ASEP system features a central computer that sends commands via telephone lines to a transponder—a small electronic unit on your electric meter. When given the command to shut down, the transponder actuates auxiliary switching units. These can be plugged into various loads (water heaters, pool pumps, air conditioners) or mounted near the fuse box. Each switch has a built-in timer that turns the appliance back on.

At the computer's command, the transponder also reads the meter. An encoder, coupled to the meter, converts dial readings into digital data. The transponder stores the data in an accumulator, a semiconductor nonvolatile memory, that won't "forget" if there's a brief power outage. At the end of the billing period, the computer calls in data from all the accumulators.

The ASEP system includes a number of other components that help utilities better monitor and control the power network. To date, successful pilot programs have been run by Jersey Central Power and Light and by Wisconsin Electric Power and Light. This summer, a full-capability system was installed for San Diego Gas and Electric.

According to Neil Jagoda, engineering director of AS&E, the system is even more than an energy-conserving tool. "The value of the system," he says, "is that utilities can use existing generators to meet increasing peak-hour demands."—*Susan Renner-Smith*

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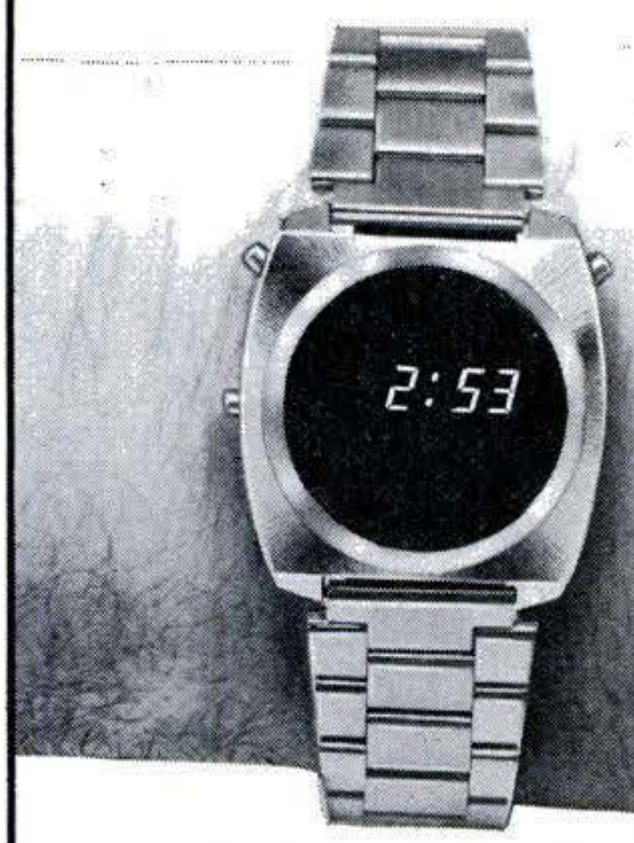

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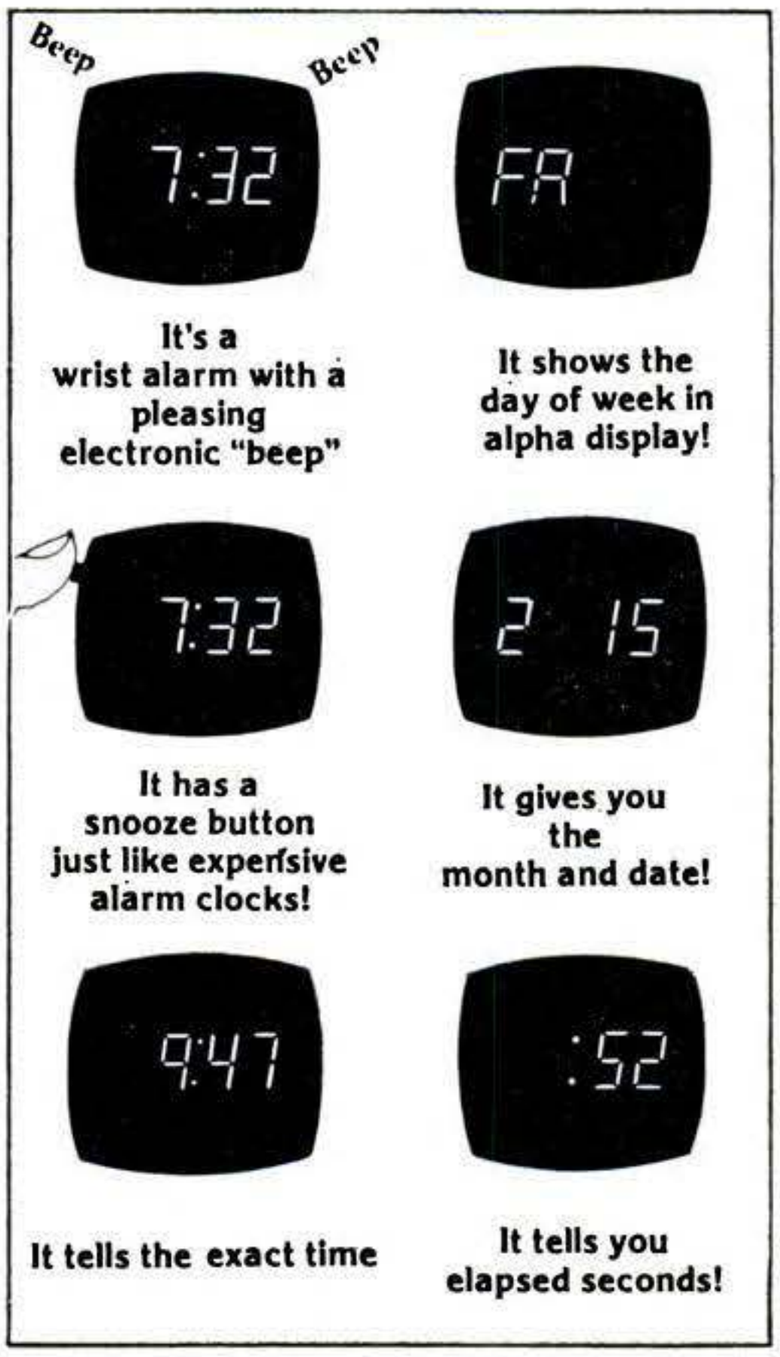

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DETROIT REPORT

By JIM DUNNE

AMC makes plans

Despite a sales slump, AMC plans to introduce a whole lineup of new cars in coming years—if its Concept 80 design exercise is any indication. Strictly prototypes, the models include a smaller Jeep and an electric-powered car. The most practical and plausible model is the Concept I, a trim, stylish subcompact. A mini van based on the Pacer and a Grand Touring coupe based on the Hornet are other appealing designs. Missing is a prototype of the future Matador.

Insurance costs

The average loss in a car accident for 1976 was $1600, an all-time high, according to the Insurance Information Institute (110 William St., N.Y. 10038). Altogether, economic losses totaled $40.9 billion for the year, a 13.4 percent increase over 1975. (Costs include auto repair, medical care, hospital room, and doctors' fees.) Accidents were up 2.2 percent, and injuries were up 5.8 percent. Fatalities rose from 46,000 to 47,100. Those are some of the reasons rates are so "unreasonable."

Chrysler gets smaller

The program will take place in two parts. This fall, the full-size Gran Fury and Royal Monaco will be dropped from the lineup; in 1979, the intermediate Fury and Monaco will die off. But in 1979 we'll see the revival of the three big-car names in different body shells. Gran Fury, Royal Monaco, and Chrysler Newport/New Yorker will be built on a stretched Volare chassis. Fury and Monaco will get a 116-in.-wheelbase version (they're 121 in. now) of the new body. The big Chryslers will have a 118-in.-wheelbase version (the current model has a 124-in. wheelbase). Cordoba and Charger will be carried over in their present form. What it all comes down to is a smaller lineup with the smaller Newport/New Yorker at the top, and a smaller size for all Furys and Monacos.

Seville will get front drive

Just as soon as GM can work the small Cadillac into its changeover schedule, a front-drive system unlike any built up to now will be installed. Target date: the 1979 model year. At that time the Seville will get a new chassis that it will share with Eldorado, Toronado, and Riviera. Front drive will be used by all four. Features of the system will include a new 325 Turbo Hydra-matic transmission that is smaller, lighter, and more efficient than the present 425. It will fit alongside the engine, which will be mounted longitudinally—as in today's Toronado. The new luxury car will have a 305-cu.-in. V8 as standard, and eventually will be built with a 231-cu.-in. V6 engine, as part of a fuel-economy-improvement program. Seville will continue as a four-door only, while Eldorado, Toronado, and Riviera will remain sporty coupes.

A gap at Chrysler

You may have missed it, but Chrysler has promoted its Volare/Aspen models to intermediate status. It's a marketing move that pits Volare/Aspen against the shrunken intermediates from GM. And that leaves the company unrepresented in the compact-car segment. In 1981, Chrysler will fill that gap with a new lineup of Plymouths and Dodges. They'll be built on a 106-in. wheelbase in three body styles including a wagon, and have a Chrysler-made 2.2-liter four-cylinder engine. The cars will be positioned directly against the new Ford Fairmont and the compacts being prepared by GM for 1979½. Reports indicate that the cars will have conventional front-engine/rear-drive chassis will offer 30-plus-mpg economy.

U.S. Rabbit no look-alike

American-built Volkswagen Rabbits, which will be in production soon, will have distinctive styling that sets them apart from their German-built cousins. Details are sketchy, but a mild rivalry is growing between the home plant and the new U.S. operation, with styling the most obvious point of difference. VW officials here dismiss the rivalry, saying that the ordering of new dies for the U.S. operations is a good opportunity to upgrade styling. Look for the use of many U.S.-type components in the American Rabbit, especially plastic underbody and trim parts.

Chrysler to build a four

Compact cars planned for 1981 will have a new U.S.-built two-liter four as Chrysler moves into the small-engine field for the first time. For the immediate future, Chrysler models will continue to use fours built overseas; the Arrow and Colt have Mitsubishi engines, and the Omni/Horizon will be powered by a Volkswagen. The basic design of Chrysler's four won't be new. It will feature an overhead camshaft and an iron engine block and head. High economy, rather than high performance, is the primary objective of the design.

Lease your car

That's what the auto industry will be telling car users in future years. The idea is to make lease payments as inevitable as your house payment. You'll eternally be paying $150 or $200 a month for your car. That way cars will be turned in every two years for new ones, and the assembly lines will turn out more. At present, with financing going four years, the car owner waits almost five years before trading in the old jalopy.

Not so impressive

Mazda, which captures more than its share of headlines in the automobile press worldwide, sells fewer car and truck models under the Mazda brand in the U.S. than it sells pickups to Ford Motor Company. Mazda is the supplier of Ford's Courier minipickup. This year Ford is expected to sell between 60,000 and 70,000 Couriers. At the same time, the combined sales of Mazda cars and trucks in the U.S. will be under 50,000, according to company estimates. PS

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Rotary Recommendation. I drive a 1974 rotary engine Mazda and would like to know your lubricant recommendations for this automobile.

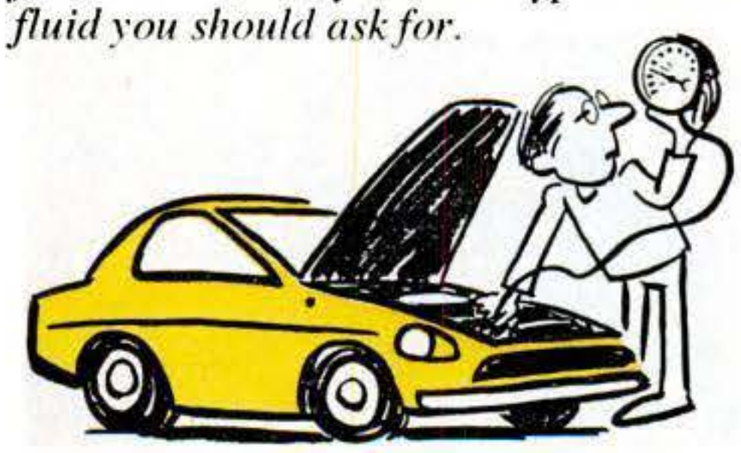
L.T., Stockton, CA

For their rotary engines, Mazda recommends the use of multi-viscosity oils only. With the temperature changes in your area, either 20W-40 or 20W-50 may be used. The 20W-50 would be preferable, if you drive your car hard and for sustained periods of time.

Fluid Confusion. I recently had my 1970 Ford Maverick transmission serviced. My transmission takes Type F fluid but Dexron II was used, and I was told it did not matter. Do you think the use of Dexron II will harm my transmission, or is it in fact, the same as the Type F?

R.M., North Babylon, New York

The difference between Type F and Dexron II is frictional characteristics. On the one hand, Ford does not want any slip in the oil. On the other hand, those manufacturers recommending Dexron II, such as GM and Chrysler, do want slip. Consequently, using Dexron in a unit not designed for it can cause clutch plate failure. We recommend that you have the unit drained and refilled with the proper fluid. Pennzoil Hydra-Flo Type F is the fluid you should ask for.



Pressure Drop. I have been using Pennzoil Z-7 SAE 30 in my Datsun 240Z with 88,000 miles, with outstanding results. However, I have been experiencing a problem with fluctuating oil pressure. The pressure is fine when I travel at speeds of 55 m.p.h., but drops when I slow down to 35 m.p.h. Do you recommend a change to a multi-vis oil to help alleviate this situation?

F.B., Tacoma, Washington

Even though you have had good success with the use of Pennzoil Z-7 SAE 30, we would suggest a change to Pennzoil Multi-Vis 10W-40 for your area. This will give you the faster engine starting and oil flow of a 10W oil when cold and the protection of SAE 40 when hot. With 88,000 miles on the engine, the oil pressure drop at 35 m.p.h. may indicate some crankshaft bearing wear. The 10W-40 oil may improve this, but you should watch this drop in oil pressure carefully since one or more bearings could be worn to the extent that they should be replaced.

Which Oil For VW. I drive a 1971 Volkswagen with a 1600cc air-cooled motor and currently use Pennzoil 30-weight oil in winter and Pennzoil 40-weight oil in summer. Would you recommend that I switch to a multi-grade?

D.L.G., West Covina, CA

Volkswagen favors the use of single grade oils in their engines with a recommendation of SAE 30 weight up to approximately 80°F., and SAE 40 above that. Although multi-grade oils such as 20W-40 and 20W-50 may also be used, Volkswagen does not suggest the use of these for temperatures above 80°F. Therefore we recommend that you stick with your present practice of rotating the single grade oils with seasonal changes.

Turning Grey. After about 2 weeks of driving (800-1,000 miles) following an oil change, I notice in addition to grey particles suspended in the oil, a grey material in the pockets, depression and under the valve covers. What do you think is causing this condition? Is it harmful to the engine?

J.L.R., Oakridge, New Jersey

The grey deposits you observe could be lead salts, resulting from the use of leaded gasoline. If they are dispersed in the oil, the dispersant additive in the oil is serving its purpose, keeping contaminants harmlessly suspended. These deposits should not be allowed to accumulate on engine parts. Accumulations such as these could be the result of excessive stop and go driving or an engine condition which allows unburned gasoline to "blow-by" into the crankcase. Overextended oil and filter drain intervals could also cause these grey deposits to build up.

Outboard Option. I have a 2½ horsepower 2-cycle Johnson outboard motor which requires SAE 40 oil (½ pint oil per gallon of gas). I have noticed that most outboard motor oils do not specify an SAE number. Can I use your Pennzoil Outboard Motor Oil for my 2-cycle engine?

J.L.C., Madison, Wisconsin

Most outboard motor oil is pre-diluted SAE 40 to facilitate instant mixing with gasoline and to lessen the chore of fuel preparation. All Pennzoil Outboard Motor Oil may be mixed according to manufacturers' specifications from 8:1 up to 50:1. You can rest assured that Pennzoil is formulated to meet the special demands of 2-cycle engines.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell *us* a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

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av. per cigarette, FTC Report DEC. '76.

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Taste. And only Winston gives me the taste
I like. Winston is all taste all the time.
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Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

Popular Science

PS | What's News

Sometimes our cover artist, Ray Pioch, goes to extraordinary lengths to keep us honest. He made a preliminary pencil drawing of this month's cover painting based on photos and blueprints that Al Lindsley sent in with his article. We sent the drawing out to the Buick people in Flint, Mich., asking for comments and corrections. They said the concept looked okay to go ahead with—although there were a few unimportant minor flaws in details. But Ray is not one to settle for "almost right." He knew there was a tiny part for which he had nothing but a verbal description to refer to—no photo, no drawing. He was unhappy to guess at precisely where it was located and what it looked like. When efforts to get a blueprint or photo of the part failed, Ray flew out to Flint. At the Buick Engineering Building, he met Buick engineer Jeff Hill, who rounded up the actual parts for Ray to sketch. If you're curious, look in the upper left-hand part of the cover painting. Part of the exhaust manifold is cut away so you can see a simple little flap valve that covers the waste gate. Those few lines and brush strokes are what came out of Ray's flying trip to Flint. To find out what it does, read Al Lindsley's story beginning on page 84.

Wernher von Braun

Creation of the Wernher von Braun Memorial Fund was recently announced by the National Space Institute. Its purpose is to "enhance public knowledge and recognition of the vital role of space in solving earthly problems, and to create the will to utilize space for the continued advancement of all peoples." Dr. von Braun founded NSI in 1974 as a nonprofit organization with leadership from all walks of life. He planned, after his retirement from government and industry, to spend most of his time helping the Institute to carry out its programs of promoting activities in space for the benefit of all humanity. When he realized, in the fall of 1976, that his failing health would make it unlikely that he could carry out his plans, he gave his name to a nonprofit, fund-raising effort to help sustain the continuation of the Institute's activities.

Dr. von Braun died of cancer of the colon on June 16, at the age of 65.

He was a rare individual, combining in one person the curiosity and knowledge of a scholar, the practical skills of an engineer, the organizational flair and drive of a manager, the enthusiasm of a cheerleader, and the human warmth to inspire incredible team loyalty among those he worked with. He will be remembered as a leader in humanity's greatest adventure—man's leap into space.

The highlights of von Braun's career are well-known: his pioneering work in rocketry before WWII, his leadership of the team that developed the V-2 rocket that devastated England, his surrender to the American forces at the end of the war, his years of anonymity working at Ft. Bliss for the U.S. Army, his development of the Redstone missile that launched this country's first satellite, and his leadership of the team that built Saturn 5, which put men on the moon.

Not so well known are some of his other activities—his writing for *Popular Science,* for example. Dr. von Braun joined the ranks of *Popular Science* contributing editors in 1963. Why would this busy man, absorbed in his history-making responsibilities, take the time to write a monthly magazine article? In his message to PS readers that accompanied his first contribution in the January, 1963 issue he wrote: "I would not be able to get any other work done were I to try to answer all those questions that find their way to my desk in my daily mail. *Popular Science's* invitation to write a monthly column on my favorite subject was thus received as both a challenge and relief. Challenge, because it always intrigues me to reduce a complex problem to terms (I hope) anyone can understand. Relief, because I am frequently bothered by a bad conscience for not having replied to some of the most enthusiastic, inquisitive, curious, and penetrating letters."

During the 13 years von Braun wrote for us, I was privileged to have many discussions with him—ostensibly to plan future stories he would write. But we always wound up discussing the entire spectrum of human endeavor. The breadth of his interests and knowledge was astonishing, ranging from the fun of skin diving to the esoterica of celestial mechanics.

I remember one visit to his office in Washington to plan the coming year's articles. It was 1971. The public had not yet heard of the coming fuel crisis. After we finished the business at hand, he started talking about the impending energy shortage. His foresight was uncanny. The depth of his knowledge about alternate sources of energy available to us was amazing. He spoke of the giant pool of geothermal hot water underlying the Gulf of Mexico and the coasts of Louisiana and Texas that could be tapped by deep wells and used to make hydrogen, which could be piped to the rest of the country. He described how we could harvest solar energy using a space station in stationary orbit and beam the energy to earth with microwaves. He talked about using the thermal gradient in the oceans and tapping the enormous energy of the swift-flowing Gulf Stream. One got the impression that, given the go-ahead, he could have led men to realizing these goals on a specific timetable just as he had in putting a man on the moon.

Another time he arrived at our offices bubbling with schoolboy enthusiasm about his trip up from Huntsville. He had piloted a Lear Jet to New York. Before we could get down to business, he had to tell us all about what a marvelous plane it was to fly. That was the first we knew that he had a multi-engine pilot's license, which he kept current.

Even during the busy days of the Apollo flights, he still found time to write his PS articles, though he did ask to reduce the frequency to every other month for that period. When he foresaw that he might not meet his deadline, either he or his secretary would phone to ask for an extension of time.

His last article for PS, "Fuel-Saving Aircraft: New Technology Promises More Passenger Miles Per Gallon," appeared in September 1976.

If you wish to make a contribution toward man's continued advancement in space, you can send donations to the Wernher von Braun Memorial Fund, care of the National Space Institute, 1911 North Ft. Meyer Drive, Arlington, Va.

Hubert P. Luckett

Editor-in-Chief

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'78 Fords
–new leaders in the economy-compact race?

New Fairmont series from Ford includes two-door sedan (top) and four-door station wagon. Sedan replaces Maverick in Ford lineup. Both wagon and sedan have smaller engines, less weight, and higher mpg levels. New compacts are as roomy as intermediates. Ford also makes a four-door sedan and will soon have a sporty coupe in this series.

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Mercury Zephyr station wagon and sedan are almost identical—except for minor details—to Fairmonts. Mercurys have four headlights. Squared-off boxy lines of compact provide more interior room for passengers; outside is smaller than Comet. Compact wagon is only one between full-size line and subcompacts.

Smaller cars and wagons with better mpg levels pace the new lineup

By JIM DUNNE

For '78, Ford introduces two new compacts, Fairmont and Zephyr—latest in the company's growing parade of small, fuel-efficient cars. They join Versailles and Fiesta in a procession of new models Ford is building to meet the fuel-economy standards of the 1980's.

Other highlights in the Ford '78 lineup are a bigger Bronco and special Thunderbird and Mark V lines.

But the most noteworthy new models are the Fairmont and Zephyr, which replace the Ford Maverick and the Mercury Comet. The new models have the exterior dimensions of a compact with the interior space of an intermediate.

Continued

All-new Bronco is built on Ford pickup chassis for the first time. It has bigger engines, full- or part-time 4WD. Almost 2½ ft. longer, it has greater carrying capacity, accommodates six adults. Forty options are available.

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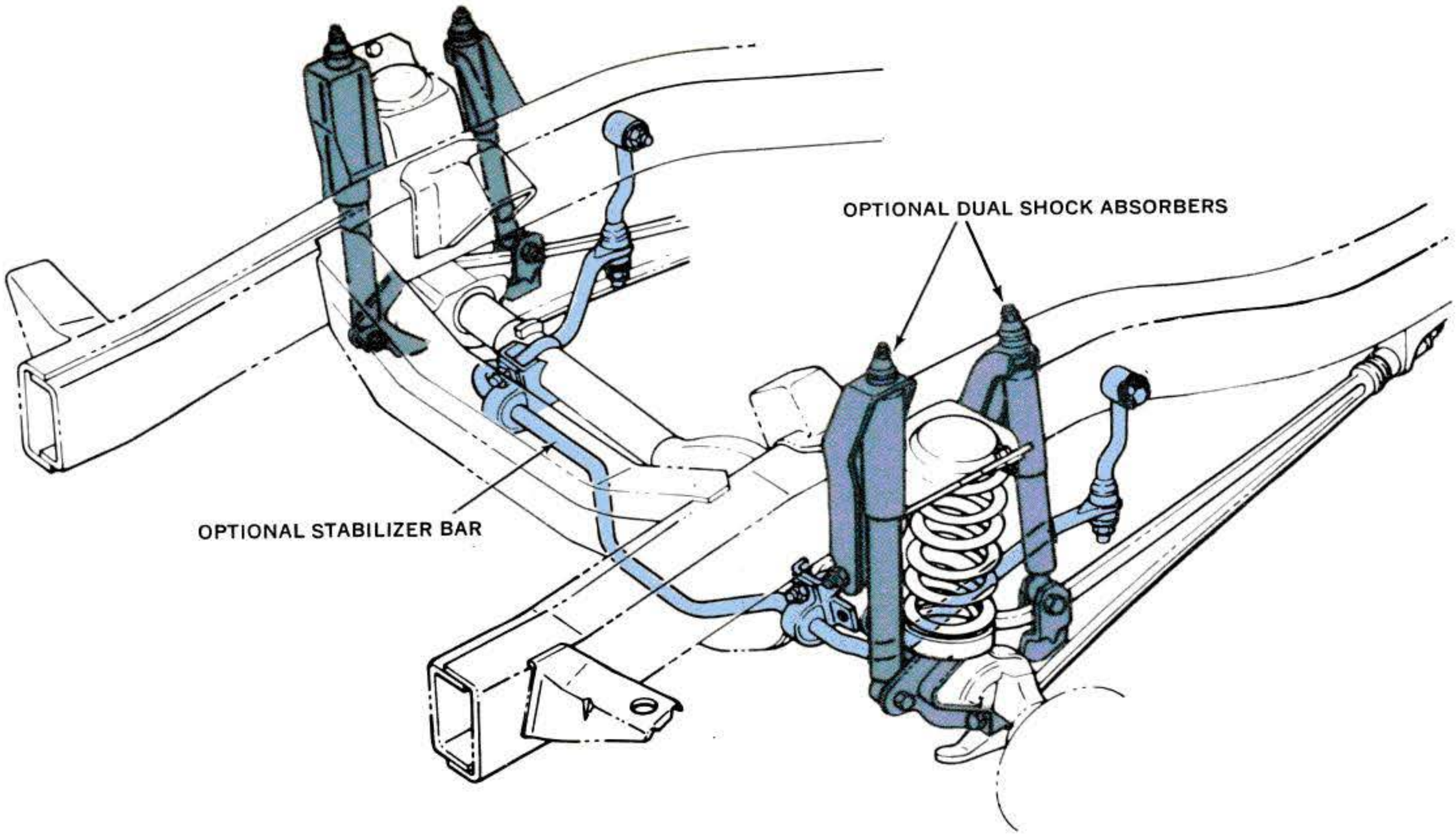

Optional suspension for Bronco's front axle has quad shock absorbers that are stagger-mounted for axle control in rugged service. Quad shocks have been used by off-road racers for some time. They provide increased damping over rough terrain. Front and rear stabilizer bars are also available. The 1978 Bronco is based on the Ford pick-up.

For all practical purposes, Fairmont and Zephyr are the same car. There are differences in the grille, taillights, and headlights, but these are superficial and do not affect major features.

Fairmont and Zephyr come in three body styles, two- and four-door sedans and four-door station wagons. Later, a sporty coupe will be added. The new models are slightly smaller and lighter, and get better fuel economy than the cars they replace.

The improved fuel economy results from the adoption of a 2.3-liter four-cylinder engine as the base power plant. Optional engines are a 300-cu.-in. six and 305-cu.-in. V8. EPA tests show an average of 26 mpg for the four, lower 20's for the six, 20 mpg for the V8. All the engines have been used in Ford cars in the past, and represent no new technology.

Our preliminary tests show that performance with the four is marginal, but that's a trade-off for high economy. The six provides good performance, while the V8 gives an extra (unneeded?) measure of acceleration.

Several steps were taken to reduce weight to EPA's 3000-pound class. The four-door weighs 2760 pounds (vs. 3088 for the 1977 Maverick). The use of aluminum for the bumpers saved a lot of weight—75 pounds. Other savings include: front disk brakes, 33 pounds; rear axles, nine pounds; power-steering components, 18 pounds.

The body and chassis are of unitized construction, with a front-engine rear-drive layout.

The front suspension is a variation of the MacPherson type with the high-rising struts, but the coil springs are on the lower control arms, away from the engine compartment. This allows more room for servicing the engine and is particularly valuable in V8 models.

The rear suspension also uses coil springs—a first for Ford in the compact class. Technically, the rear suspension is described as a four-link system that is lighter in weight and has less internal friction than the conventional leaf-spring design. Two links are positioned above and two below the axle to prevent axle rotation during acceleration and braking, and to reduce wheel hop. Springs and shock absorbers are mounted outboard of the frame rails close to the wheels, where they can do the most work in absorbing road-surface changes.

Ford engineers say they kept several goals in mind in making these changes: controlling noise, vibration, and harshness; improving handling; and maintaining good ride. The design of the basic structures helps achieve the goals, as do the addition of rubber insulator bushings between the suspension and the body.

Fairmont/Zephyr power steering is also a first for Ford. It's a rack-and-pinion type with variable-ratio gear settings. On center the ratio is relatively high—20.1:1—to provide ease of control at highway speeds. But as the steering wheel is turned, the ratio falls to 14.2:1, so fewer turns are needed for parking and cornering. A special rack has teeth set at uneven spacings to provide the variable ratio. The same steering components, except for the rack, are used in both manual and power-assisted systems. The system is exclusive to Fairmont/Zephyr in the Ford lineup, and is said to be the first of its kind made by an American manufacturer.

The most striking feature of the new models is the body design. It has a balanced appearance with a hood long enough to cover an in-line-six engine and a trunk bustle at the rear. With straighter side panels, and a boxy shape, the body provides exceptional interior space for five passengers, equal in many respects to intermediate sedans. All major roominess measurements except rear leg room in the four-door model have been increased over the 1977's. The trunk, with 16.8-cu.-ft. volume, is laid out with a flat floor. The spare tire is stowed under the trunk floor.

The lowered beltline and low

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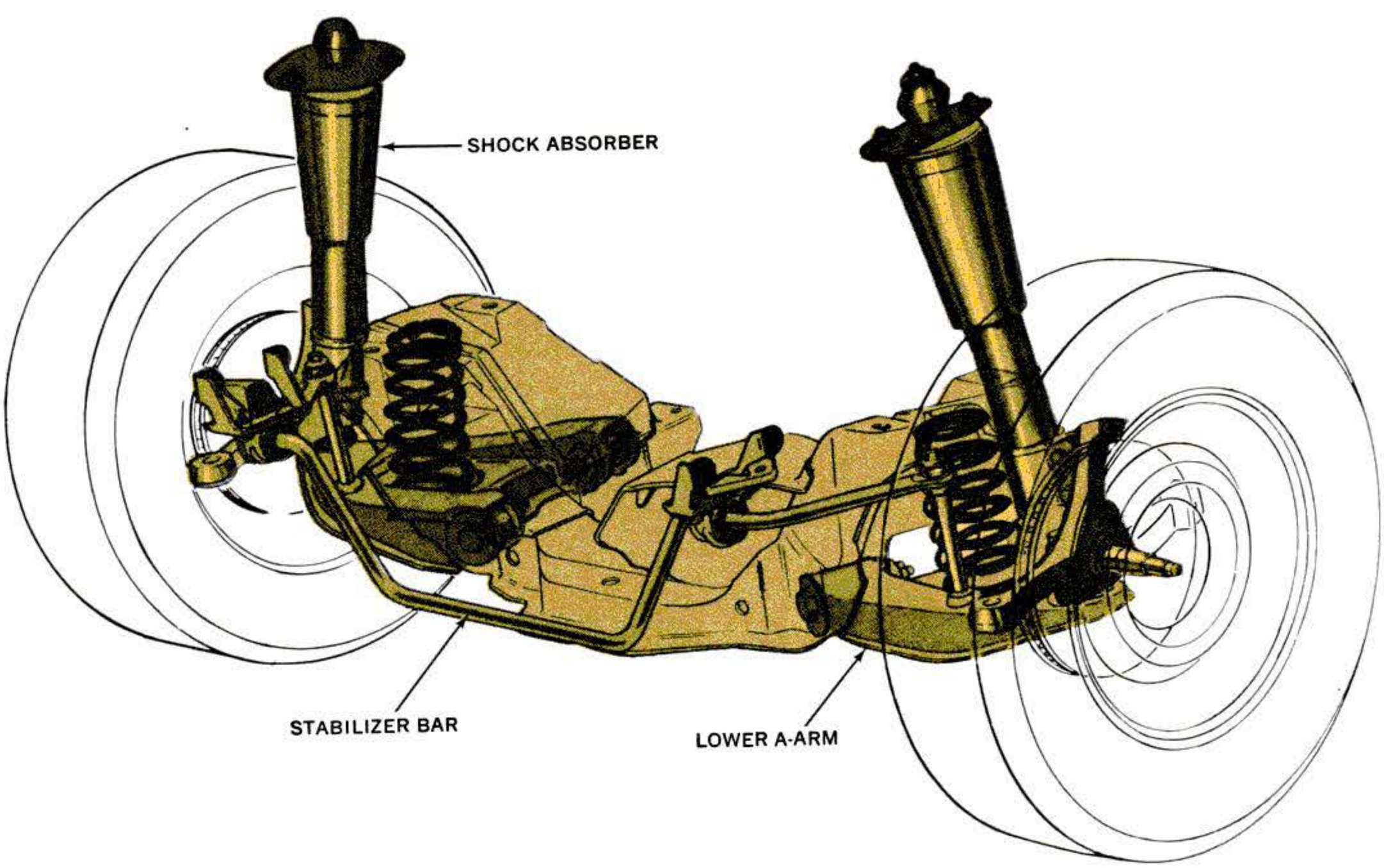

New front suspension that uses some of the top features of the MacPherson design and eliminates engine-compartment crowding is introduced on the Fairmont Zephyr. Components include standard stabilizer bar, coil springs mounted on lower control arms, plus an improved shock strut and large bushings at all attachment points.

placement of the windshield base were adopted to improve driver visibility and to impart the feeling of sitting in a "command" position. But the low position of the seating surfaces, a hallmark of recent Ford designs, all but negates the visibility advantages. Only with the "high-line" optional seats does the driver occupy that "command" position. The less expensive seats are set close to the floor, where passengers lose the advantages of the lowered greenhouse.

The instrument-panel layout seems uninspired to this observer. Gauges are set in a horizontal panel that extends to the middle of the dash panel, while controls such as turn signals, headlamp dimmer, horn, and windshield wiper and washer are incorporated in stalks on the steering column.

Station-wagon models feature a hatchlike rear door and fold-down rear seat that make its maximum 79.5 cu. ft. of cargo space readily accessible from either the rear or side doors.

For its 75th anniversary year—1978—Ford is building special Thunderbird and Mark V lines. The Diamond Jubilee Mark V is touted as the "ultimate luxury package."

The balance of the Ford and Mercury lineup remains unchanged, except that station wagons in the LTD II and Cougar series have been dropped. Styling and mechanical revisions for the other lines are minimal, though Granada and Monarch have a new front-end appearance that features single-lens rectangular headlights.

A major revision changes the Bronco from a one-of-a-kind utility vehicle to a Blazer look-alike. The 1978 model is based on the Ford pickup.

Built on a 104-in. wheelbase, the Bronco is 180.3 in. long, almost 2½ ft. longer than the 1977 model. It will carry six adults, or the rear seat can be folded forward to provide additional load space. The standard engine is the 351-cu.-in. V8; the 400-cu.-in. V8 is the only option. Both part-time and full-time four-wheel-drive systems are available, along with a host of options—including 40 new ones—that match anything offered in the 4WD utility-vehicle field.

The Versailles has "interactive electronic controls" on its 351-cu.-in. engine. Called EEC 1 by Ford engineers, the system automatically adjusts the exhaust-gas-recirculation rate (EGR), and determines the spark-advance setting. A solid-state electronic module receives data from sensors located around the engine, including those that report crankshaft position, throttle position, coolant temperature, manifold pressure, barometric pressure, and EGR-valve position. The system uses a new sonic EGR valve that gives greater control of EGR flow and offers more complete mixing of EGR with the fuel/air mixture. EEC 1 provides more precise emission control and better engine performance.

California-destined Pintos and Bobcats equipped with the 2.3-liter four-cylinder engine and automatic transmission will have Ford's first electronically controlled carburetor and three-way catalyst. The very complicated system is seen as a testbed for three-way systems to be used on other Ford products in future years. It uses sensors in the catalyst to determine how close the air/fuel mixture is to stoichiometric (the air/fuel-mixture ratio that promotes the most complete combustion, about 14.7:1). If the mixture is overrich, say 13:1, it is automatically leaned out by moving fuel-inlet needles inside the carburetor. The opposite happens when an overlean mixture is sensed. The system also receives information from other engine functions to keep the air/fuel mixture to an acceptable level.

The catalyst in the three-way system consists of two monolithic ceramic substrates mounted in the same stainless-steel cylinder, located in the exhaust system between the engine and muffler. The term "three-way" refers to the catalyst's ability to reduce the three separate emission contaminants—hydrocarbons, carbon monoxide, and oxides of nitrogen. PS

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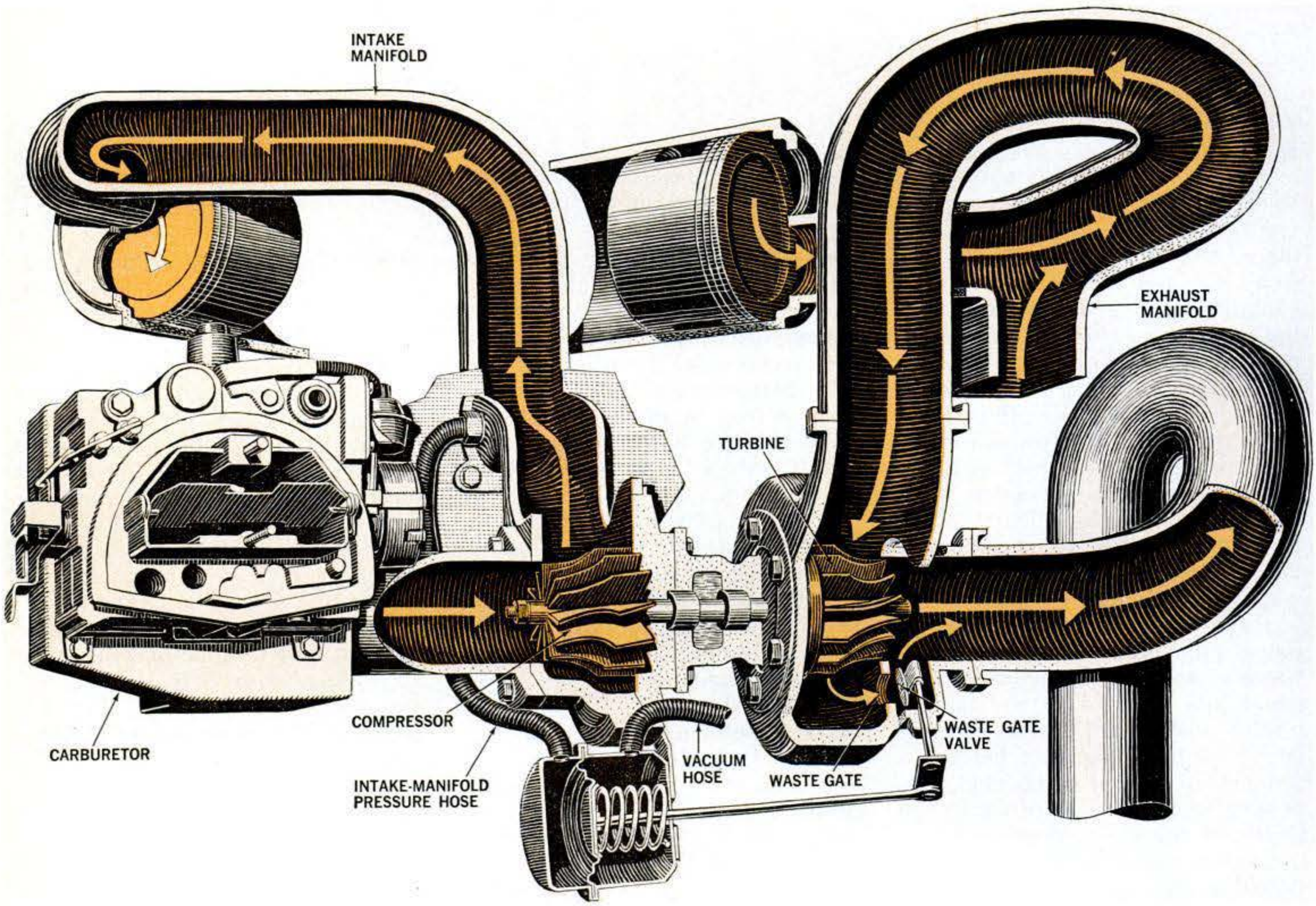
Buick's turbocharged V6

Is it the engine of the '80's?



How it works. Exhaust gas passing through the turbine makes it turn. The compressor is connected to the turbine by a shaft, so that the compressor wheel turns at the same rpm as the turbine. Although the turbine is turning whenever the engine is running, it doesn't spin the compressor fast enough to provide boost until you step on the gas. For example, cruising at a steady slow speed with the engine running at 1500 rpm, the turbine would be turning in the neighborhood of 25,000-30,000 rpm. At this point the compressor is supplying no boost. The rotating compressor wheel is merely acting as a fuel/air atomizer. But when the accelerator is depressed, for passing, say, the throttle in the carb opens wider. That lets more fuel/air mix be drawn into the cylinders. With more fuel/air mix now in the combustion chambers, you get hotter combustion temperatures. Thus the temperature of the exhaust gas rises sharply. The hot, rapidly expanding exhaust gas makes the turbine spin much faster and the compressor becomes more than an atomizer: It forces more fuel/air mix down into the combustion chambers (boost) than they could suck in by themselves. Operated by a spring-loaded bellows, a waste gate prevents the turbo from over-revving and providing too much boost. A hose runs from near the compressor housing to the canister. This lets intake-manifold pressure push against a flexible bellows with a spring on the other side. When manifold pressure reaches eight psi, the spring lets the bellows move, opening the waste-gate valve, and diverting some exhaust gas away from the turbine. A vacuum hose tapped into the PCV line augments the canister's operation. At lower rpm, the waste gate is completely closed; all exhaust gases pass through the turbine.

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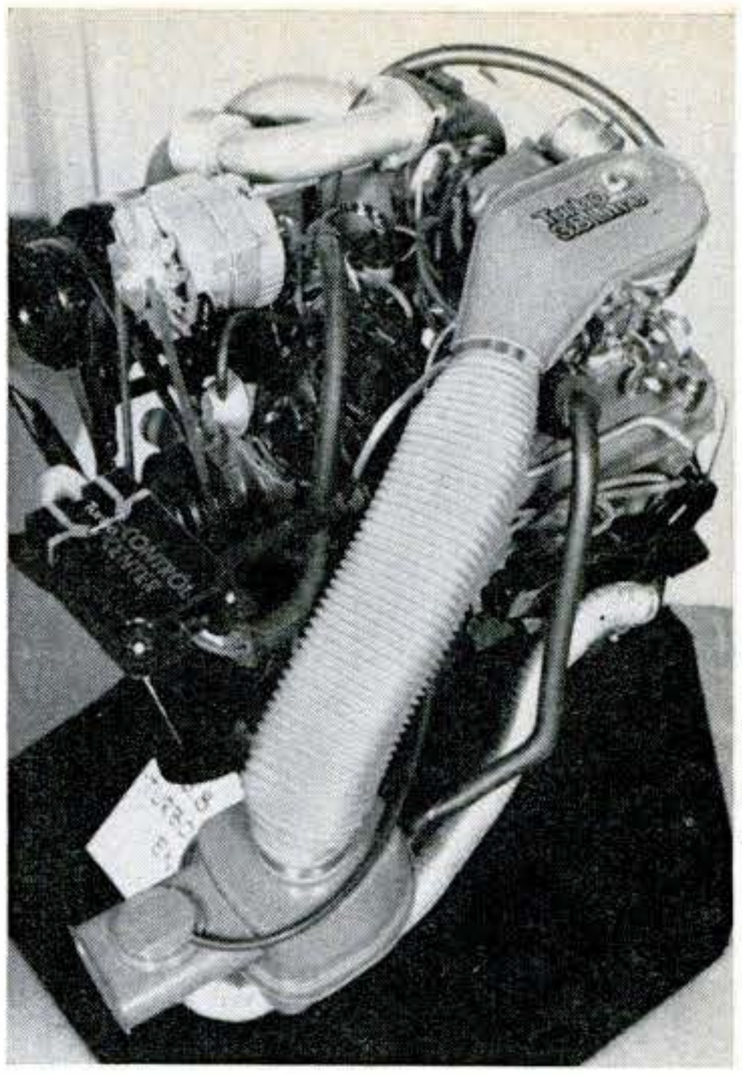
By E. F. LINDSLEY

Spinning almost silently at an easy 50,000 rpm, the little turbocharger under the hood was merely loafing as I swung around a freeway entrance ramp at modest speed. But when I spotted a gap in traffic and pressed down on the gas, the impeller wound up almost instantly. Driven by high-velocity exhaust gas striking the miniature turbine on the opposite end of the shaft, it reached—according to Buick project engineer Tom Wallace, sitting beside me—140,000 rpm or higher. At the same time, I felt a satisfying surge of power that let me slip the car into the traffic flow without a fuss.

Although most of us have always thought of turbochargers (turbine-driven superchargers) as exotic riggings for race cars and hot sports cars, that idea is dead-opposite the design philosophy explained to me by Buick's chief engineer Lloyd Reuss, when he talked of Buick's upcoming turbocharged V6's. "We wanted six-cylinder EPA fuel economy and V8 performance," he said. "But we had a totally different design objective from previous turboed cars aimed at all-out max power at top rpm."

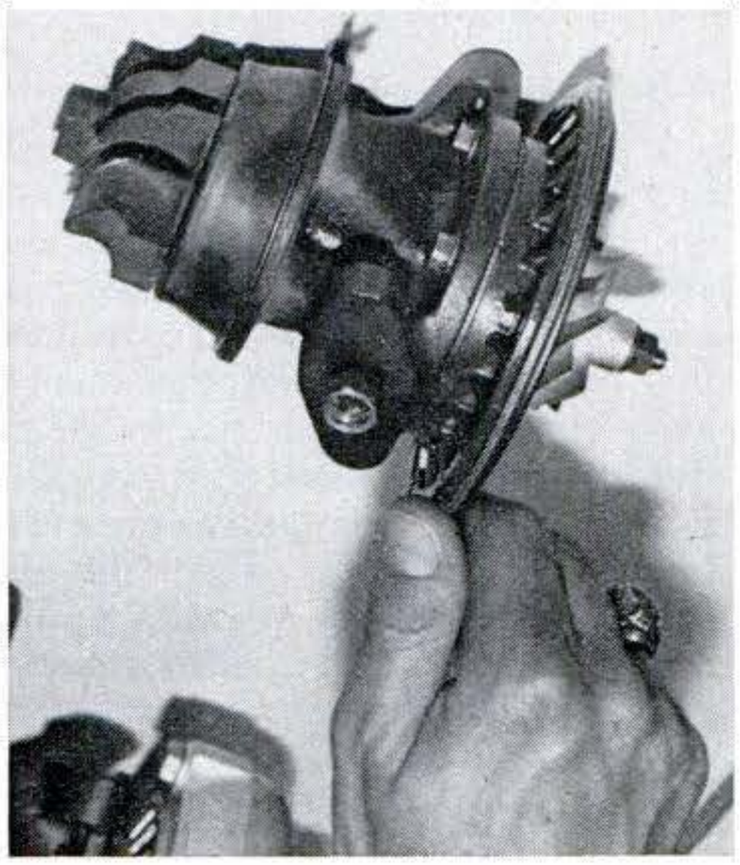
Since you'll probably hear more about turbos as carmakers strive for better performance and economy from smaller, lighter engines, let's take a look at just what a turbo is and what it can do.

An internal-combuston engine is basically an air pump. Without supercharging, the engine depends upon atmospheric pressure to force air into the void left in the combustion chamber when the piston descends. Natural aspiration limits the size of the fire you can build on top of the piston, and also the amount of air available to expand against the piston.



V6 turbo engine looks like this before installation. Black box, "Turbo Control Center," up front, senses beginning stages of pre-ignition and adjusts timing.

Turbocharger is small and light. Turbine end and waste gate are on the left. Compressor, which forces more air/fuel mix into manifold, is on the right.



Compressor wheel, at right, has blades that are curved differently from those of the turbine wheel, left. Connected by a shaft, blades turn up to 150,000 rpm.

Supercharging simply means providing an auxiliary air pump to force more air into the combustion chamber. There are different ways of doing this: an engine-driven centrifugal blower; an engine-driven lobe type (Roots) blower; an exhaust-turbine-driven centrifugal blower.

Both the lobe type and centrifugal blowers driven by the engine consume substantial power just in the driving process. Worse, the expensive and complex belt or gear drives waste power all the time unless they have clutches—and that adds to their complexity.

A turbocharger, however, is not connected to the engine by a mechanical drive in any way. At one end of a single shaft is a heat-resistant turbine that somewhat resembles a child's pinwheel. It spins in the exhaust-gas stream much as a waterwheel does in a stream. On the other end of the shaft, a similar but lighter impeller grabs the air and pushes it into the intake manifold at high velocity.

Since the air flowing in the manifold passes through the intake valves only as they open, this high-velocity air is partially blocked. This raises the pressure in the intake manifold and it becomes possible to force more air into the combustion chamber. As you open the throttle, pressure will increase, as indicated on the manifold pressure gauge. Opening it further will cause

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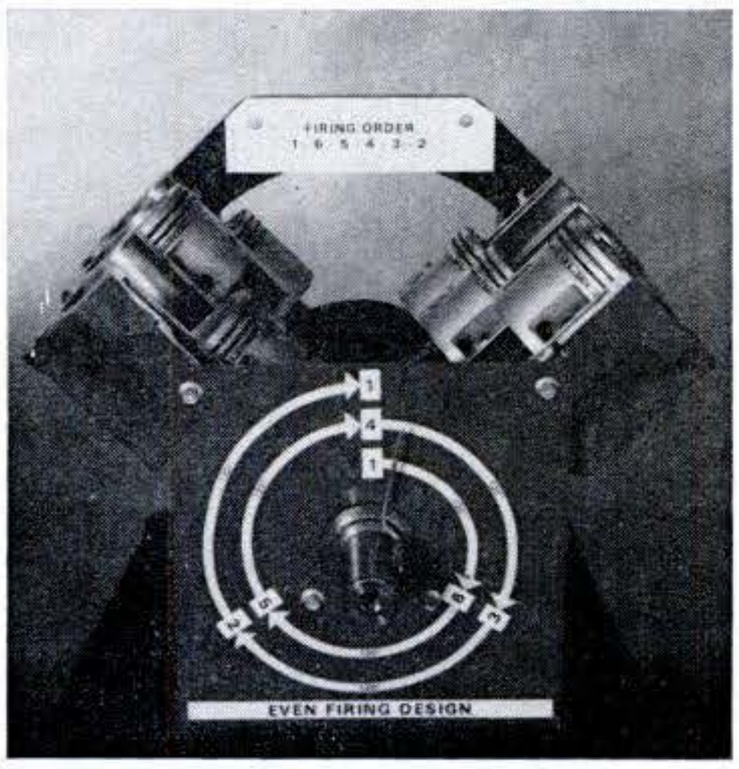
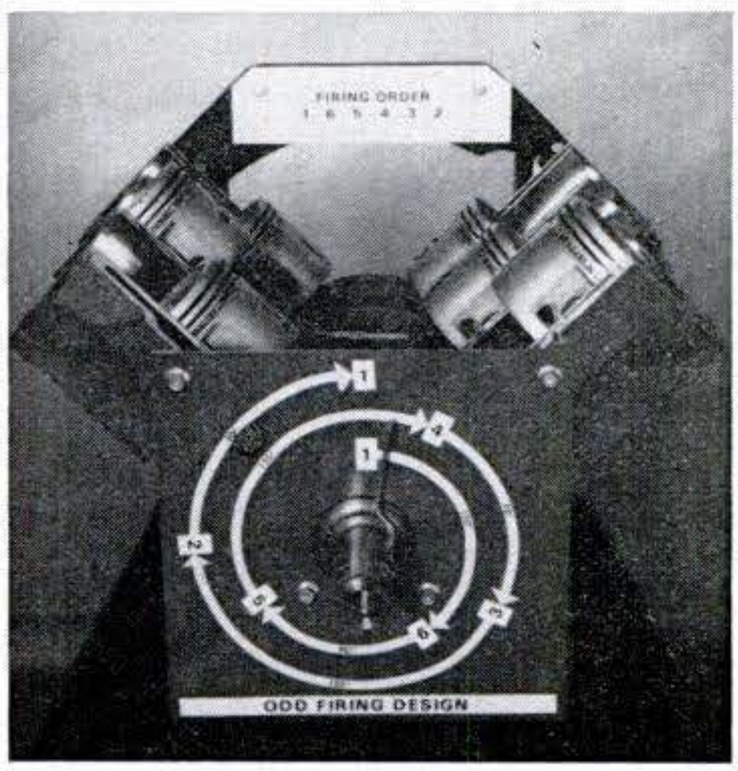


V6 engine for 1978 is even-firing, resulting in smoother-running engine than past V6's, which were odd-firing. The even-firing engine receives one firing impulse for each 120 degrees of crankshaft rotation. In the odd-firing design, a firing impulse occurred at 150 degrees, then at 90 degrees. In order to get the engine to fire every 120 degrees, the crankshaft was redesigned.



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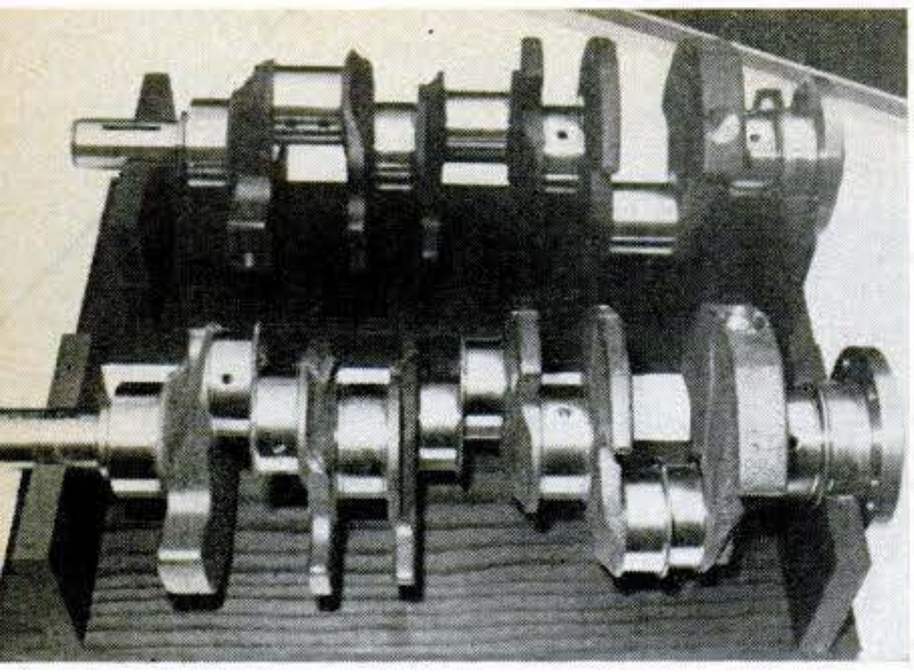
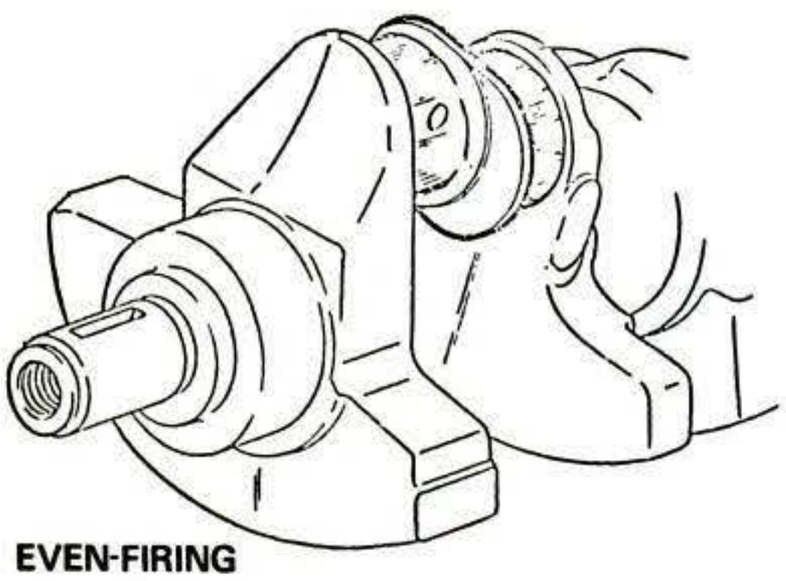
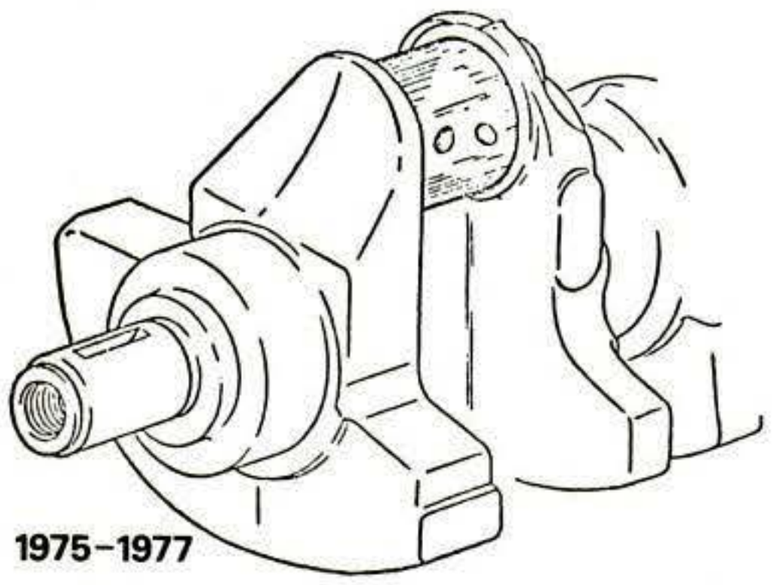




EVEN-FIRING



1975–1977

Offset crankpins on the new V6 engine's crankshaft allow a piston to arrive at top dead center with every 120 degrees of crankshaft rotation. Photo shows the odd-firing crankshaft (top), new crankshaft with offset crankpins.

the pressure to rise above atmospheric pressure, producing what the engineers call "boost."

What's really great about a turbo is that all of this is done without mechanical load on the engine. The heat energy normally wasted as exhaust spins the turbine.

The tricky part is making the turbo do what you want it to do when you want it to. Probably the most common way to keep this whirling mechanical dervish under control is with a waste gate or spill valve, which is simply a Y in the exhaust passage. Close the waste gate and all of the exhaust gas passes through the branch of the Y that goes to the turbine; open the gate and you divert some gas past the turbine. By proper automatic modulation you supply the amount of gas to the turbine that suits the engine's load demand.

(Note: This type of turbo should not be confused with the turbochargers used on aircraft. They're intended to provide compensation for the loss of atmospheric pressure as you climb to higher altitude. They are called pressure-drop turbines: As the difference between exhaust pressure and atmospheric pressure increases during climb, the turbine comes into play.)

In the past, the desire for high-speed performance caused auto engineers to cut in the turbo way up on the performance curve. The turbo gave additional peak power, although it often took annoyingly long to reach supercharging rpm. According to Lloyd Reuss, Buick has taken an opposite tack. The new engine uses the turbo for low- and medium-range passing and acceleration loads from about 1200 rpm up; then it starts opening the waste gate near the top end to prevent overloading the engine.

A new set of problems

If all of this seems easy enough to make you want to pick up a used farm-tractor turbo and bolt it on your car, here are some things that might slow you down. To induce fuel flow, your carburetor normally makes use of the difference between the atmospheric pressure in the float bowl and the negative pressure in the venturi throat. Push the air from a supercharger through a carburetor at more than atmospheric pressure and the picture suddenly changes: There will be more pressure in the carburetor throat than in the float bowl. The fuel would want to run backwards, so the float bowl has to be pressurized. This introduces a whole new set of problems. To begin, you'd need a stronger fuel pump to feed the pressurized float bowl. All of the carefully worked out carburetor-venting techniques, a very strict antipollution constraint, must be discarded. The carburetor must now have seals, even at the throttle shaft.

These are reasons why add-on superchargers have always been headaches. And that's why Buick decided it was much better to put the carburetor on the intake (suction) side of the turbo. Engineers at Buick can use their standard carburetor, fuel pump, and vacuum controls, with a few minor changes.

Another important aspect of forcing more air into the combustion chamber is the potential for destructive knock or detonation, especially on today's 91-octane gas. Buick wants to get the best possible performance during the periods when the turbo is called into action, and this means advancing the spark right up to the edge of detonation. To prevent engine damage and still enjoy good performance, engineers devised a closed-loop system with a detonation detector mounted on the engine to pick up the beginnings of marginal detonation. If this happens, the sensor feeds back to the distributor and trims the spark advance as needed.

Another change for the new V6 is a new crankshaft that permits even firing (see illustrations).

Questioning the experts

I was still bursting with questions as I talked with Reuss, assistant chief engineer Cliff Studaker, and Tom Wallace. I asked about intercooling. After all, compressing air raises its temperature, and many turboed engines include a cooler to lower that temperature before the air enters the manifold. Doesn't power-boosting require a lot of beefing up in the engine? Doesn't the added power require extra cooling? What about emissions?

Their answers were reassuring. "Yes, occasionally turbo outlet air temperatures might reach 200° F if you were pulling a heavy trailer up a mountain. But this wasn't a problem, because most of the time the air would not exceed 180-190°, and this is about what they run naturally aspirated with the present intake air-heating devices." As to loads, "the basic engine block, bearings, heads, and rods were more than adequate." The only real change was to provide stronger pistons, revised rings and ring-belt configurations, and a different camshaft designed to improve low-end performance.

The automatic transmission in a turbo is also tailored to get low-end response in a hurry. It lets the engine wind up quickly when you pull out to pass another vehicle. In response to the question on cooling, I was told that Buick will use a V8-size radiator since the engine is, on demand, producing V8 power. Interestingly, the present emission package works just fine because on the EPA driving cycle the turbo comes into action only about five percent of the time.

Whether other carmakers will opt for turbos remains to be seen. It would seem that a device so commonly used for so many years on tractors, trucks, and power-plant engines would be a natural for the automotive industry to cut weight and fuel use. PS

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Buick Regal

–new turbocharged V6 in a smaller intermediate

By JIM DUNNE

Buick's Regal, the first of GM's A-body cars to make a debut for 1978, is packed with new features that only start with its turbocharged V6. Besides its engine, which is sure to be a trend setter, the car embodies major changes that are designed with an eye to the problems of the fuel-scarce years ahead.

Regal is Buick's personal luxury coupe in the intermediate line. It's smaller on the outside, lighter in weight, and more fuel-efficient, but with a roomier and quieter interior.

Some other passenger-section improvements include a newly designed instrument panel that places instruments and gauges in one group in front of the driver, and other controls—radio, heater and air conditioner—in a center section where they can be reached by both driver and passenger.

Built on a 108-in. wheelbase (vs. 112 in. in 1977) and with an overall length of 199 in. (vs. 209.8 in.) the '78 edition weighs 3190 lb., 500 less than its predecessor. Smaller sizes and substitutions in materials and components—such as the new aluminum hood, which saves 50 pounds—contributed to the weight loss. Other changes include plastic inner-fender skirt panels that replace metal ones, smaller axles and tires, and thinner side glass. Fuel economy has been improved 10 percent to an estimated EPA average of 22 mpg.

Buick compares the performance of the Regal turbocharged V6 to that of a 350-cu.-in. V8. Driving the turbo presents few surprises, once you get used to the idea that so much power can come out of so small a package.

The V6, with a four-barrel carb, has less low-speed torque, though. The turbocharger does not come into play until the engine reaches 1200 to 2000 rpm, which is slightly below midrange for the engine.

Buick engineers claim that the car rides better than the longer-wheelbase 1977 models, thanks to careful matching of springs and shock absorbers to the wheelbase. The ride motion, partly a subjective measurement, seems smooth and controlled.

Noise control is another high-priority feature. New rubber disks atop the front springs block metal-to-metal road noise transfer, making for a quieter ride. PS

New size and styling are immediately noticeable in the 1978 Regal. Important engineering advance is turbocharged 231-cubic-inch V6 engine, balanced for V8 smoothness. A new smaller and lighter high-pressure spare tire—standard on the Regal—leaves more load space inside the trunk, and is always inflated. The tire is designed for emergency use only, not for continuous driving. Although the turbocharged engine produces more power, it creates crowding problems under the hood. Exhaust is routed on top of right side of engine and covers two rear spark plugs on that side. Gauge on instrument panel shows boost in three stages: none, moderate, and full.

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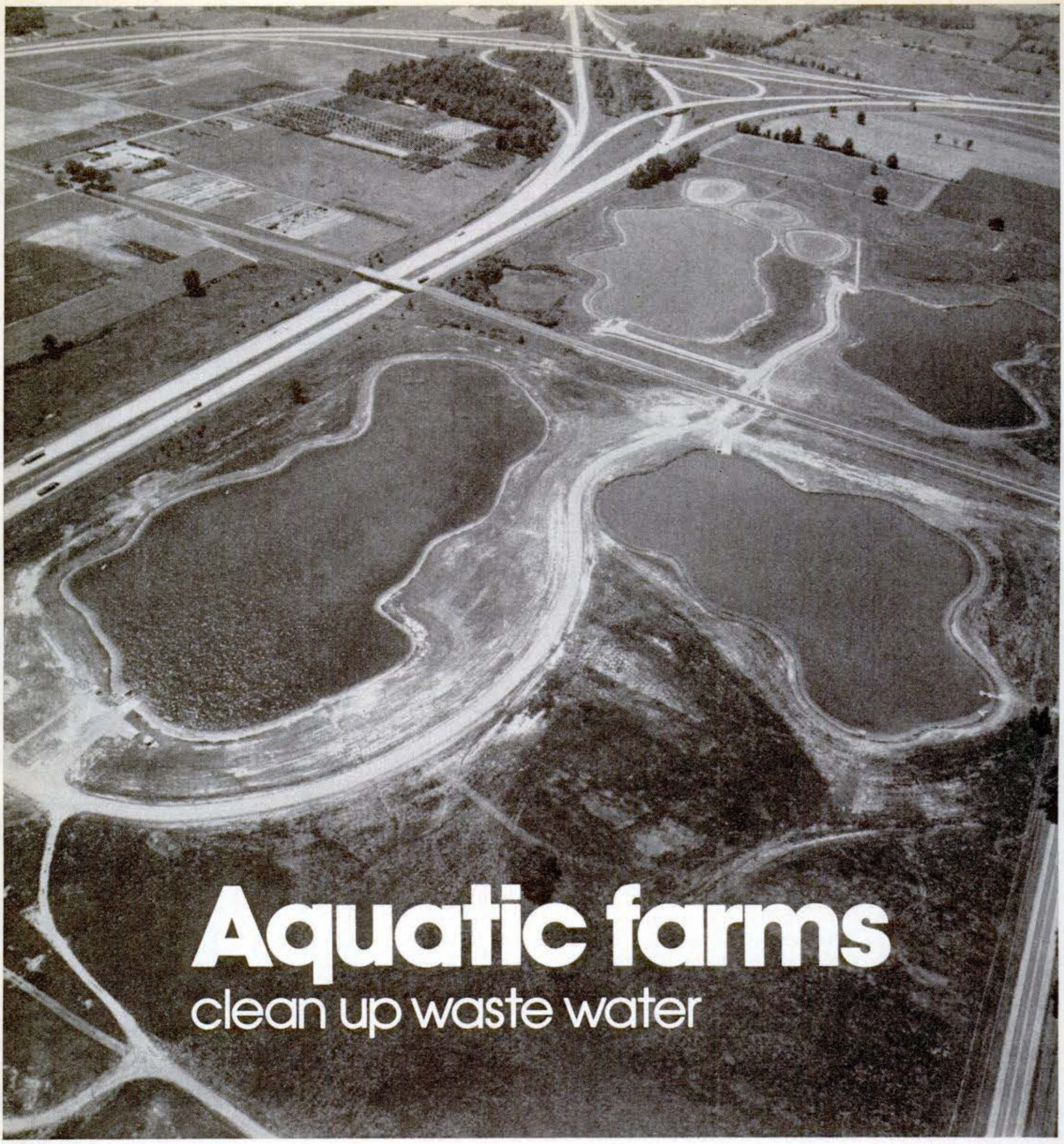

A cluster of lakes at Michigan State's Lansing campus transforms lake-clogging pollutants into feed and fertilizer.

New sewage treatment produces crops, fertilizer, and good fishing

By BOB SEAQUIST

A baler moves slowly along a windrow of hay, packaging it for later use as cattle food. It's a typical scene on Michigan farms—but in this case, the farmhand pitching hay is a lake scientist. The hay itself is actually *Elodea*, an aquatic weed, and the field producing this rich harvest is a 12-acre lake.

The harvest is only part of a water-recycling experiment run by Michigan State University at East Lansing. There, lake scientists are proving that moderate-size cities can deal with sewage cheaply, using little energy, and at the same time produce a rich silage for farm animals, recycle valuable phosphorus and nitrogen, and even provide darned good fishing. These benefits are byproducts of a wastewater-treatment process aimed at removing the pollutants that foul our water.

Existing sewage-treatment plants, even though they meet public-health standards, don't remove much nitrogen or phosphorus from their final discharges. Both chemicals are nutrients, common ingredients in your lawn fertilizer. When released in natural waters, they cause rampant growth of algae and water plants. These eat up oxygen in the water, making it uninhabitable for game fish. Bodies of water eventually become

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victims of eutrophication: They become clogged with weeds, silt up, and "die."

At East Lansing, scientists put the eutrophication process to work, using treated sewage to grow water plants suitable for both feed and fertilizer. The wastewater is also pumped into an irrigation system. Rich-looking field crops absorb the valuable nitrogen and phosphorus, reducing the need for costly solid fertilizers. And plump, fighting bass are planted in the cleaner portions of the lake project, making fishing great sport for MSU students working on the experiment.

Joining lakes is the key

The system's design is simple. Four small, man-made lakes on the fringes of the university campus are connected in series. The East Lansing sewage-treatment plant sends about two million gallons of treated wastewater a day—roughly the amount generated by a town of 40,000—to the first lake. There, the sun and the rich nutrients in the sewage stimulate the growth of large numbers of algae and aquatic plants, a process that absorbs much of the nitrogen and phosphorus.

After the harvest, dead algae and leftover chemical compounds flow along the carefully engineered lake bottom to an outlet, where they are pumped to adjoining fields for spray irrigation. Surface water from the lake flows by gravity to the next lake, where the process is repeated. By the time the water reaches the fourth lake in the series, it's clean enough for fishing and other recreational uses. From the last lake, the clean water is released into the nearby Red Cedar River. By this time, it exceeds the strictest water-quality standards.

Clean-water catch is displayed by assistants Mark Halter and Thomas Rohrer.

Using a rake, technician Steve Kilcus harvests a crop of lake-cleaning weeds.

"Low-cost renovation of water for alternate uses must be a major goal for the future," says Dr. Howard Tanner, one of the MSU scientists who helped start the project. Dr. Tanner, now director of Michigan's Department of Natural Resources, reports that water reuse is already being practiced in areas where water is in short supply. He states: "The technology of renovating water is expanding; such systems offer significant possibilities for major use in the future."

Weed cutting is tricky

Future uses are quickly forgotten when lake scientist Joe Ervin loudly curses the baler he's using. Ervin, as the water-quality project's field supervisor, is in charge of getting those water-weeds harvested. The former farm boy is having problems getting conventional farm equipment to work with water-weeds. They would rather jam the machines than be put up into neat bales for livestock feed.

For Ervin, the entire harvest is frustrating. The project is so new that every operation is a first. The staff has gone through several weed cutters, which failed for various reasons: Some were too small for the large harvest; some had outboard motors whose props were fouled in the weeds; and some just weren't built very well. The machine now being used, a paddle-wheel-propelled 12-foot barge, is armed with a hydraulic sickle bar cutter at its bow. The barge is having problems with its motor's governor, so it needs both a pilot to guide it through the weeds and a helper who tries to keep the motor running at the right speed.

When the cutting is finished, the cutter bar is replaced with a front-mounted rake used to scoop the floating weeds onto the lake's shore. According to Ervin, it's a real trick to lift the heavy weeds far enough onto the shore so that a tractor can spread them out to dry.

"Before we learned the trick," he said, "a couple of tractors went for quick lake dips when the front wheels got too close to the water's edge."

The project is still so new that all material harvested—the water-weeds, crops from the irrigated fields, the water itself, and those mouth-watering bass—are still carefully inspected. "We must make a major effort to check for the persistent organics and other toxic materials that escape the conventional sewage-treatment processes," says Dr. Tanner. According to him, the basic goal of the project is to "zero in on the more delicate areas of environmental impact."

The MSU project is now in its second year, and both Tanner and Ervin say it's "working." Ervin adds, "It's making a significant contribution to wastewater treatment." He expects that the information gained will allow many communities to have their own low-cost, high-quality sewage-treatment facilities. By the 1980's, we may be insisting that our local sewage plant not only produce sparkling clean water, but also provide agricultural benefits and recreational areas for our communities. PS

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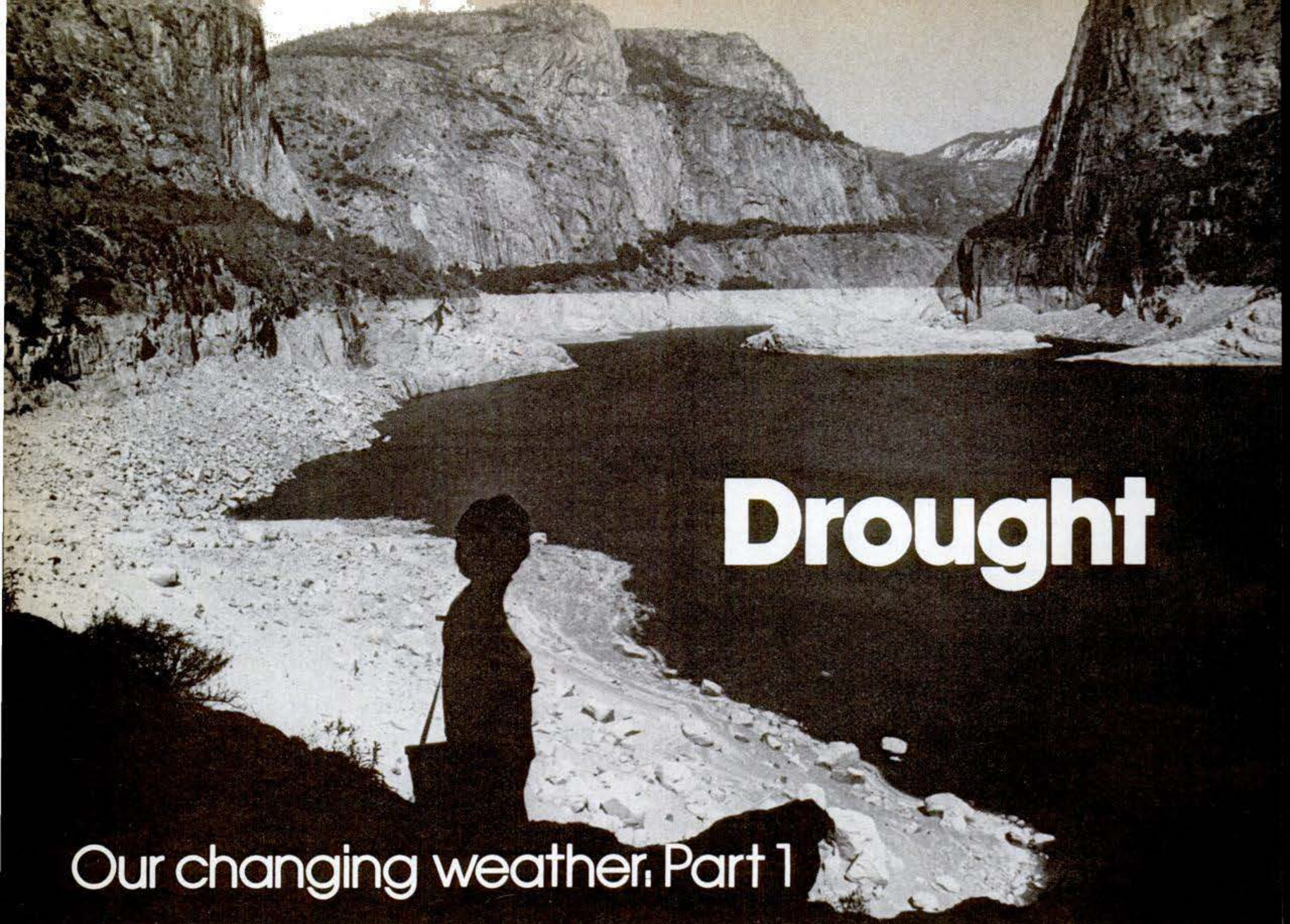

Drought

Our changing weather: Part 1

Mountains of snow and record-breaking cold in the Northeast, severe drought in the Far West . . . strange things have been happening to our weather lately. We asked prizewinning science writer George Alexander to go to the experts, find out what's going on, and why, and give us a forecast for the near—and far—future. His two-part report begins on these pages; it will conclude in the October issue of Popular Science.

By GEORGE ALEXANDER

By the start of this summer, the effects of America's long dry spell were visible throughout the withered West. But, even as scientists sought to uncover the many factors underlying drought—indeed even before they could tell whether the current drought has ended, or will continue for another few years—they were trying to persuade the public to begin preparing for the next dry spell *now*.

"It should be obvious," commented Stephen Schneider, a climatologist with the National Center for Atmospheric Research. "Droughts of extreme severity and extended longevity are precedented events on the Great Plains."

Indeed, many observers fear that the Great American Drought of '77 is not an isolated event, but instead is part of a general scrambling of the planet's climate.

The world's weather began acting up in 1972, after about 15 consecutive years of benevolent stability. That was the year the Russian wheat crop failed because of inadequate rains, and the Russians made their first huge purchase of American grain. It was also the year that the monsoons failed to appear in India and Southeast Asia, and the Sahara Desert expanded its desolate reaches across Africa.

In 1974, when rainfall on the Great Plains fell below average, agricultural experts, aware of the world's dependence on American harvests, began expressing concern about fluctuations in the planet's climate. England and much of northern Europe experienced, in 1976, the driest summer in a long, long time. That was also the year now taken as the start of the drought in northern California. And, although the Pacific Northwest enjoyed above-average rains during the 1975-76 rainy season, it was clear by then that there was sand in the meteorological gearbox.

Dry, bleached rocks in California's Hetch Hetchy Reservoir are normally under water. But by last April the water level had shrunk 244 ft., and the reservoir held only about 24,840 acre-ft. of water. When full, it holds about 360,000.

And then came the bizarre winter of '76-'77. In the U.S., the Western drought spread and became more severe; outdoor ice rinks melted in Alaska; and the East was hit with the most savage winter in more than a century.

We know the immediate culprit behind last winter's extremes: The prevailing westerlies wandered off course. But what if this wasn't just a temporary aberration? Is the recent bizarre weather an ominous portent of a long-term trend?

Many experts think it may be. Climatologists, meteorologists, astronomers, even dendrochronolo-

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gists (tree-ring daters), have compiled records of cyclical weather changes. The records span various time scales, from the 22-year double-sunspot cycle, through hundreds of years of tree-ring growth, to ocean-sediment records that are thousands of years old. Although some are more persuasive than others, the cycles match up well enough to show a definite pattern of climatic change.

Records of sunspot activity and tree-ring growth indicate that our recent harsh weather is not historically unusual, but simply a return to "normal" weather patterns for this continent.

Analyses of ocean sediments point to an even more chilling conclusion. They confirm a long-proposed theory that predictable variations in the earth's orbit and rotation cause periodic ice ages. On that basis, at least some scientists say that our recent weather is part of a global climate change leading to another ice age.

On these pages, we focus on the Western drought—what caused it, and why we have reason to believe it's part of a regular pattern. Next month, we'll explore the theory that the frigid winter of '77 was a sign of things to come, not only for America's Northeast, but for the world.

Wandering westerlies

The immediate cause of the Western drought was what meteorologists call "the Pacific semi-permanent high-pressure cell." This is a high-pressure ridge that builds up in autumn over the western U.S. and keeps Pacific storms from reaching the Southwest. It usually collapses by early winter, letting the westerly winds roll in and deliver rain and snow to refill reservoirs and mantle mountain ranges.

But for two years running, the ridge has stayed on well into winter. In 1976 it shunted the westerlies up to Oregon and Washington, depriving northern California of rain. Last winter, it kept the westerlies not only from California but from most of the Pacific Northwest and a wide swath of the Rocky Mountains. The westerlies were steered instead far to the north, into Alaska. The result: unseasonable warmth there and harsh cold throughout most of the East (see maps).

Many meteorologists believe that the underlying causes of the winter of '77 can be found in the complex interplay of westerly winds and huge ocean "pools" in the Pacific.

Jerome Namias, a meteorologist with the University of California's Scripps Institution of Oceanography at La Jolla, is one. For the past few years, says Namias, a giant pool of sea water with surface temperatures three to four degrees above normal has been lying off the West Coast. The pool extends from about 120° to 140° west longitude and from 20° to 60° north latitude. Another pool, two to five degrees cooler than normal, extends from about 140° west over to Japan.

These warmer and cooler pools interacted with the winds flowing above them to create a trough over the cooler water and a ridge over the warmer. The result: Instead of tracing a gently rippling, west-to-east course, the westerlies hopscotched across the Pacific in a series of south-to-north loops. On the last turn before the North American continent, these high-altitude steering winds were almost parallel to the West Coast as they streamed out of the south and into the north.

A synergistic cycle

"Being warmer—since they were moving up from the equatorial region—the winds extracted very little heat from the water," says Namias. "In addition, southerly winds tend to push some warm water from the equator toward the north. They also discourage upwelling of the colder water underneath, so there's less water vapor going into the air and fewer clouds being formed. And that means more sun striking the water, and *that* means the water doesn't get a chance to cool off; it stays relatively warmer."

Other experts would add still more elements to Namias's model. They believe there is a hierarchy of cause and effect: An individual season, such as the winter of '77, is an outgrowth of large-scale disturbances in the planet's atmosphere. Those disturbances, in turn, are related to fluctuations in the sun.

Climatologists have long been intrigued by the fact that droughts seem to recur every 20 years or so

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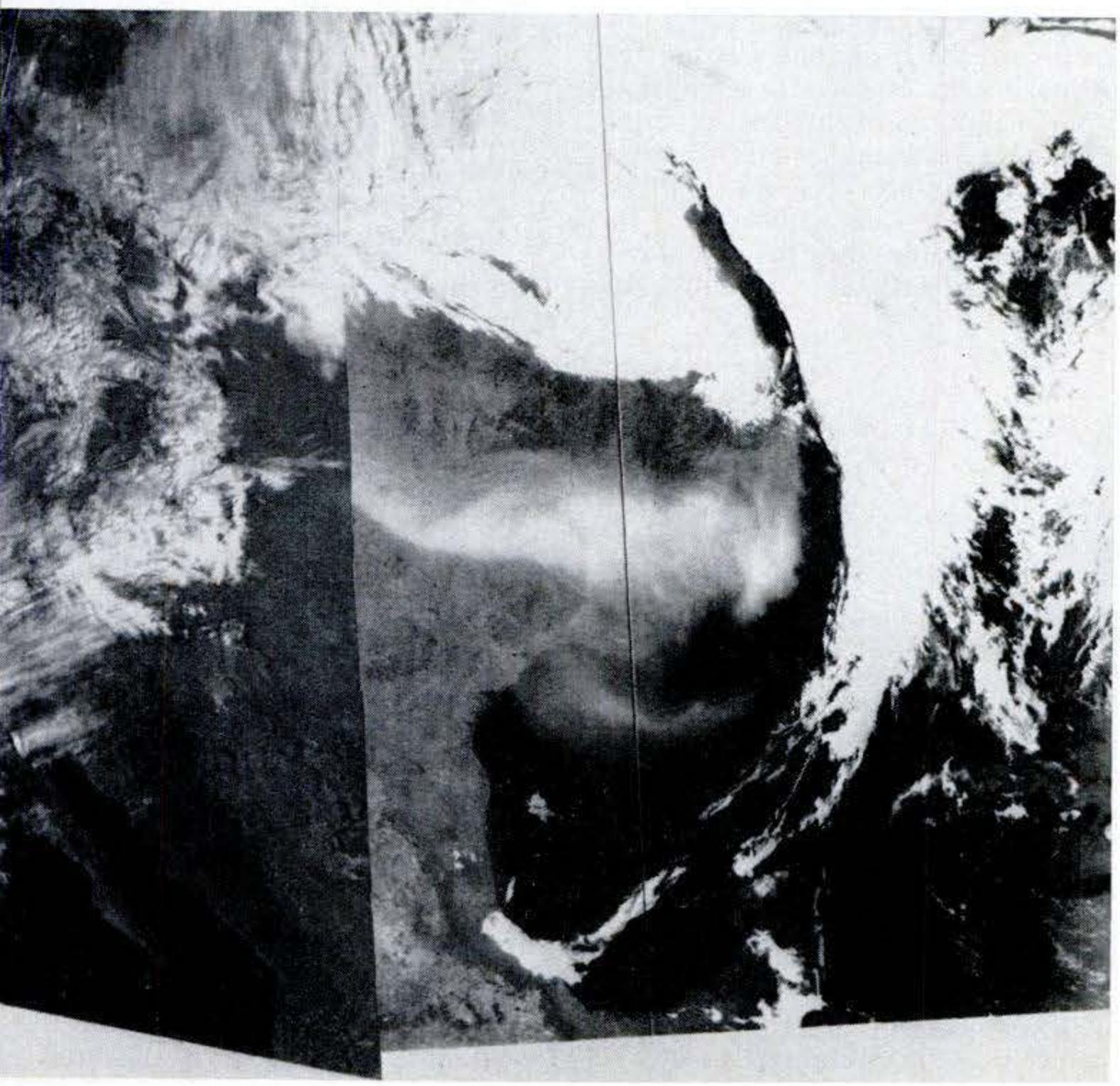

A massive dust storm, the largest since the Dust Bowl days of the 30's, swirls across the U.S. The dust, topsoil from the drought-parched West, was scooped up by winds streaming down the Rockies, and whipped 15,000 ft. high into the air. In February, when it was photographed by satellite, the dust cloud stretched from New Mexico east to the Carolinas, and from the Gulf of Mexico north up to Kansas.

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on the Great Plains. They've also noted a possible relationship between dry spells and "minima" in the solar cycle—times when sunspots all but disappear.

Sunspots and drought

The sunspot cycle takes roughly 11 years to progress from minimum to maximum and back again. A double cycle typically spans 22 years. When climatologists talk about a possible connection between sunspots and drought, they're referring to alternate minima, or every other minimum.

The western U.S. had droughts in the 1880's, 1910's, 1930's, 1950's, and now the 1970's. Alternate minima have occurred at those same times. Can the two be somehow related? Some experts say no. They point out that no one has yet advanced an acceptable theory to explain the connection between sunspot cycles and droughts. Also, the American West is practically the only drought-stricken region on Earth that seems to be paced by the sun. Further, neither the time nor the duration of sunspot cycles and droughts match up with unvarying precision.

Nevertheless, a dendrochronologist and a meteorologist believe that there is a definite connection between the two. Charles W. Stockton of the University of Arizona's Laboratory of Tree Ring Studies, and J. Murray Mitchell, Jr., of the National Oceanic and Atmospheric Administration, met at the 1976 meeting of the American Association for the Advancement of Science. There, Stockton showed a slide illustrating the varying geography of past droughts in the western U.S. The data, based on records of tree-ring growth, revealed that the total area affected by drought expanded and shrank in distinct cycles.

Stockton hadn't calculated the frequency of these cycles, but Mitchell, who was sitting in the audience, thought he could see a pattern of 20-year periods. He later sought out Stockton, and borrowed the data to check his theory. Mitchell found a 22-year frequency,

> "The underlying causes of the winter of '77 can be found in the complex interplay of westerly winds and huge ocean 'pools' in the Pacific"

give or take two years, in the geographical peaks of widespread aridity. The actual *average* interval between extensive droughts was 20.4 years. Mitchell found this correlated with those sunspot cycles that had a particularly strong maximum half. "The strong-sunspot cycle runs short," he explains. "Ten years instead of 11. So a double cycle, when it's strong, runs 20 years instead of the usual 22."

Walter Orr Roberts, former director of the National Center for Atmospheric Research, feels that it's probably a mistake to attempt to call sunspots "cause" and droughts "effect." "I don't think the sunspots are causative," he says. "I think they're symptomatic, along with the droughts, of something deeper going on in the sun."

What that "something" might be remains to be determined. However, Roberts notes that whenever the edge of the solar magnetosphere sweeps over the earth, "we get a decrease, just a couple of days later, in the index of strong cyclonic activity in the Northern Hemisphere. It's a change, if you will, in our 'storminess.' "

Since forces at work in the sun reveal themselves on this scale of a few days, Roberts is convinced that there must be forces that reveal themselves on the 20-22-year scale of droughts.

Indeed, the evidence linking solar events and terrestrial weather is growing. Robert Holzworth and Forrest Mozer of the University of California at Berkeley recently reported finding that solar flares in August, 1972, set off a series of reactions in Earth's atmosphere. These culminated in a worldwide increase in thunderstorms.

Such small-scale weather changes appear to be caused by a stream of high-energy solar protons produced by the solar flares. These protons slam into the gassy envelope surrounding the earth, where they have three major effects:

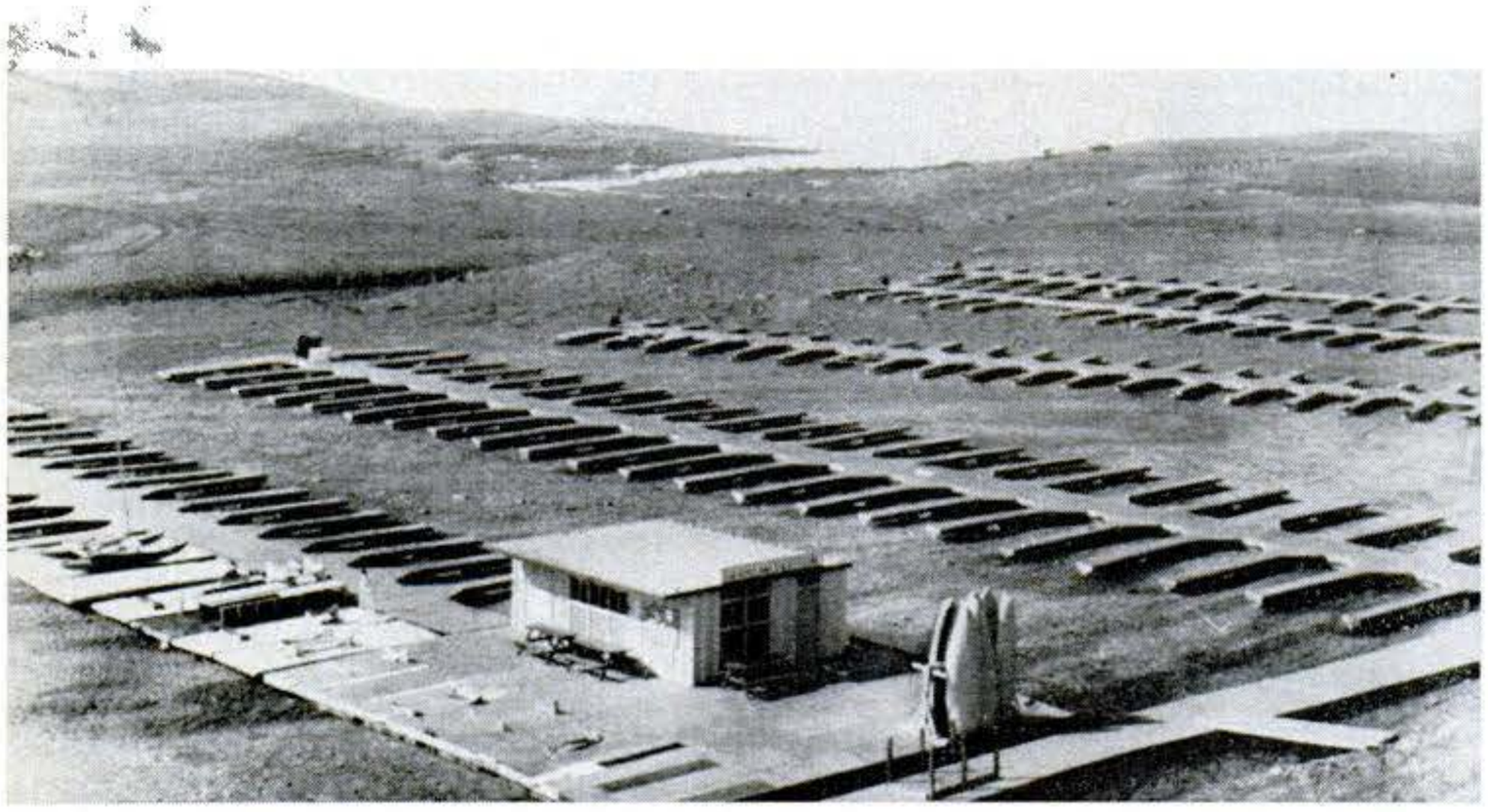
- They change the electric-field distribution in the upper atmosphere.
- They decrease the conductivity of the lower atmosphere.
- They screen out cosmic rays from galactic sources.

And solar flares are not the only sources of these high-energy, weather-affecting protons: Sunspots also generate them.

Tree rings: climate data banks

Whatever the cause of our recent troublesome weather, it's becoming clear that droughts and severe winters may not be freakish departures from the norm. One way we know this is through the same tree-ring data that Mitchell and Stockton used for studying drought cycles. The science of dendrochronology (from the Greek words for tree and time) provides us with a comprehensive picture of past climate changes.

By coincidence, A. E. Douglass, the first dendrochronologist, was an astronomer who studied sunspot cycles. Because he thought the cycles might affect climate, he began checking the growth patterns of annual tree rings. (A tree builds a wider ring during a warm, wet year than during a cool, dry one.) Douglass failed to confirm his sun-



Abandoned docks perch eerily above the waterline at a marina on California's Folsom Lake. By February, the lake had retreated several hundred yards from the slips, and had shriveled down from one million to 288,000 acre-ft. of water.

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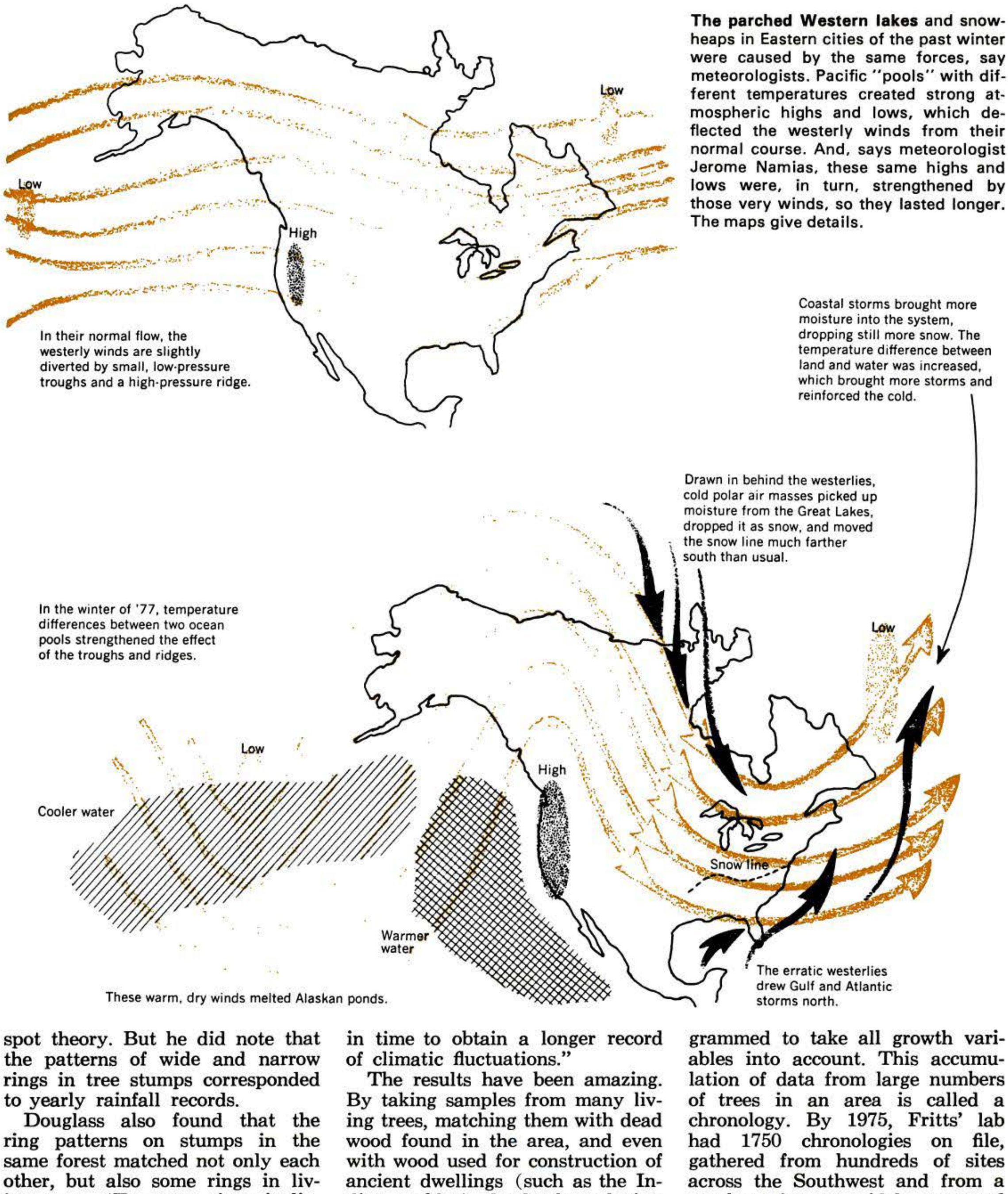

The parched Western lakes and snow-heaps in Eastern cities of the past winter were caused by the same forces, say meteorologists. Pacific "pools" with different temperatures created strong atmospheric highs and lows, which deflected the westerly winds from their normal course. And, says meteorologist Jerome Namias, these same highs and lows were, in turn, strengthened by those very winds, so they lasted longer. The maps give details.

spot theory. But he did note that the patterns of wide and narrow rings in tree stumps corresponded to yearly rainfall records.

Douglass also found that the ring patterns on stumps in the same forest matched not only each other, but also some rings in living trees. (To count rings in living trees, researchers use a boring tool to extract a thin, horizontal core. The hole is plugged, and the tree is unharmed.)

Douglass' discovery that tree rings could be cross-dated was the key to the whole science of dendrochronology. Harold C. Fritts, head of Arizona University's tree-ring lab, explains: "By finding dead trees that overlap in time the ones for which ring patterns have been dated, one can go backward in time to obtain a longer record of climatic fluctuations."

The results have been amazing. By taking samples from many living trees, matching them with dead wood found in the area, and even with wood used for construction of ancient dwellings (such as the Indian pueblos), dendrochronologists have compiled 2250 years of tree-ring records for the Southwest. Using eastern California's bristlecone pine tree, which can live for 4000 years, they have gathered 8200 years' worth of tree-ring records.

Of course, accurate dating is only the first step in reconstructing past climate. Once dated, the rings from an array of samples are carefully measured, then fed into a computer, which has been programmed to take all growth variables into account. This accumulation of data from large numbers of trees in an area is called a chronology. By 1975, Fritts' lab had 1750 chronologies on file, gathered from hundreds of sites across the Southwest and from a number of more widely scattered sites in the rest of North America, Europe, Asia, and the Arctic.

"When many trees are sampled from a variety of sites over a wide geographic area, the ring widths offer a wealth of information on the environment that is highly correlated with the regional climate," explains Fritts.

He and his group also use computers to translate tree-ring chronologies into climate information.

Continued

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Water-saving—the West's new challenge

The drought, the strict mandatory rationing imposed by some water districts, and the realization that water is likely to be scarce for years to come combined in 1977 to revive interest in a variety of water-management ideas, some practical, some fanciful.

Weather modification, specifically cloud-seeding, was suggested as a way of setting things right. But, said experts, seeding works only when certain types of clouds are present; the method cannot break a drought.

Desalination plants and iceberg towing also surfaced—and also sank—the former because of cost and the latter because of too many uncertainties. And the Ralph M. Parsons Co., a major engineering and construction firm, again dragged out its pet project. For the past 13 years, Parsons has been proposing a $150 billion, 30-years-to-build, transcontinental ditch. It would carry water from Alaska, through Canada to the lower 48 states and Mexico. But no one has bought the idea.

On the more practical side, there's water-recycling. Many California residents have been collecting gray water from bathtubs, sinks, and washing machines to use for toilet flushing and plant watering. And several recycling machines were put on the market in early '77. These devices force the gray water under pressure through a series of filters that remove suspended matter, then add chlorine. The recycled water is usable for everything but drinking.

Such devices are aimed at the residential user. Industrial wastewater requires more elaborate treatment. Even so, several California manufacturing companies have installed extensive recycling systems.

Beckman Instruments, for example, installed a wastewater-treatment facility in its Porterville, Calif., plant. The plant, which produces printed-circuit boards, reduced its water consumption from 1½ million gallons per month to less than 400,000 gallons.

Drip irrigation is another water-saving technique. In this method, water seeps through very fine holes in a series of pipes that are either buried or laid on the surface. Drip irrigation has a number of advantages over conventional soaking sprinklers. Less water is lost to evaporation, and water is delivered more effectively to the roots, especially when the distribution network is underground. The technique uses less water than other methods, and so is cheaper. Reduced water costs, however, must be weighed against the costs of installing a drip system: It may not be worth it for the small home garden.

The need for these and other water-management techniques is urgent. For, as one water expert remarked recently about future water supplies: "I have good news and bad news. The bad news is that we're all soon going to be forced to drink recycled water. The good news is that there won't be much of it."—*G. Alexander*

First, the computer matches the known recent climate of an area with varying ring widths and develops a scale relating the two. The scale is like that on a thermometer or rain gauge—it's used to convert ring-width data from years before climate records were taken into estimates of temperature and precipitation.

Using these methods, dendrochronologists have reconstructed climatic variations in North America back to the year 1600.

Ring widths throughout the Rocky Mountains and Colorado Plateau were found to be generally narrower from the 17th to 19th centuries than those since 1900. As Fritts explains, this pattern of narrow rings means that winters were dry in the West and cold in the North and East—much like the winter of '77.

In another study, the dendrochronologists matched barometric-pressure records of recent years with tree-ring chronologies from the same area. Air pressure doesn't directly affect tree growth, but it does affect precipitation, which is a major growth factor. The lower the pressure, for example, the greater the rainfall, and the wider the tree ring. As they expected, the researchers found a correlation between the air-pressure records and recent tree-ring patterns.

The next step is to go back into time, use tree-ring data to draw barometric maps for years before such records were kept, then deduce climate from the patterns shown on the maps.

The researchers reconstructed atmospheric-pressure conditions for North America back to the year 1700. Fritts recently reported the chilling results: "Since 1900, 16 percent of winters have exhibited anomalies of atmospheric pressure that brought increased wind flow from the Arctic and severely low temperatures to the North American midcontinent; and 36 percent of the summers have experienced anomalies and high temperatures in some areas, leading to drought. The corresponding percentages for 1700-1899 were, respectively, 30 and 42 percent. Thus in the modern period there have been 14-percent fewer winters conducive to extreme cold and six-percent fewer summers conducive to severe drought." In other words, our winter weather for the last 75 years has been relatively mild.

> "Large-scale disturbances in the planet's atmosphere are related to fluctuations in the sun"

But what about drought? Once again, tree rings tell an unnerving tale. Stockton, for example, matched stream-flow records kept in modern times with rings of trees growing in the river basin. (Both tree growth and stream flow are affected by climatic variations.) Then he reconstructed stream flow back to 1564 and compared it with modern records. His findings: The wettest 25 years in the whole 400-year period fell in the years after 1900. And, the mean annual flow between 1896 and 1963 was *15-percent higher* than the mean for the entire 400 years.

What's in store?

All of the data uncovered about drought seems to point to an uncomfortable conclusion: The era of abundant water may be over, at least for the foreseeable future.

As Schneider says emphatically: "Anyone who thinks that the mild and stable weather patterns enjoyed by the U.S. in the last 25 years or so are the rule, rather than the exception, is living in a fool's paradise."

Does this mean that we must prepare not only for periodic droughts but also for more severe winters? The October issue of POPULAR SCIENCE will take a look at the hard, cold facts. PS

Annual growth rings tell more than a tree's age; their varying widths signify climate changes. Thus, ancient trees reveal the climates of past millenia.

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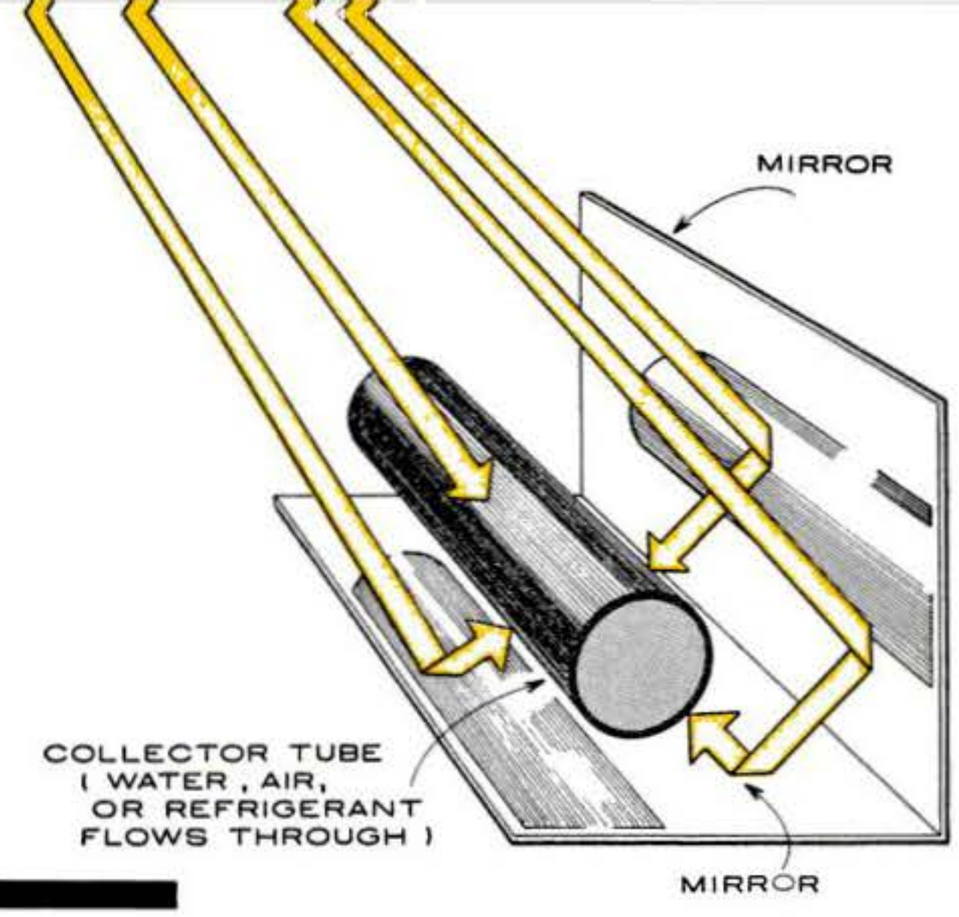
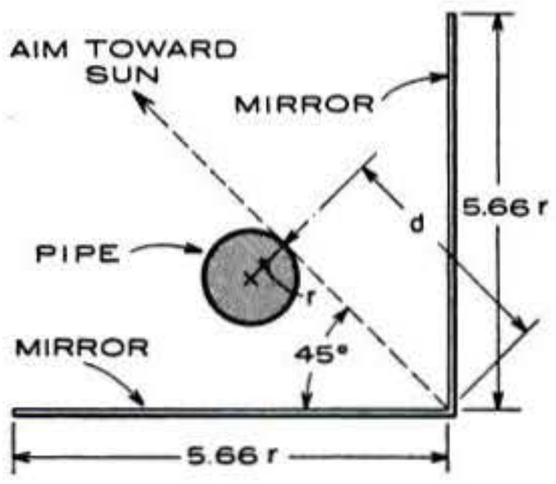
Concentrating **solar collectors** you can build



By WALTER E. MILLER JR.

Any solar-energy enthusiast can pretty easily buy or build a low-cost, simple flat-plate collector. But sometimes you want higher temperatures than are possible with flat panels. For this you need a solar concentrator [PS, Oct. '76]. These typically use a large curved mirror or lens to focus the sun on a smaller absorbing medium, and employ tracking mechanisms to keep the system pointed toward the sun. And typically, too, they're complicated and costly.

It seems to me, however, that there could be a middle-ground approach—using flat mirrors. The sketch above illustrates the basic method. Two perpendicular mirrors form a reflector that concentrates solar energy on a horizontal tube through which flows a heat-transfer fluid. This gives considerably less optical gain than does a parabolic reflector, but it produces *four times* the energy concentration of a flat panel, with a resulting increase in temperature.



Small directional solar collector

Design and construction are simple. And the collector is quite versatile: It can be designed for minimum mirror size with a limited solar-acceptance angle (top diagram below); or, with larger mirrors, it can be designed with very large solar-acceptance angles—approaching 90° (see middle diagram)—at some loss of efficiency.

This large acceptance angle is particularly attractive. Other reflectors or lens concentrators have a narrow field of view and must be continuously aimed at the sun as it travels across the sky. Not so with this design. A field of view between 50° and 80° will be wide enough to allow you to collect solar energy over most of the United States from a single fixed year-round pointing angle (determined primarily by your latitude).

When designed according to the table here, the collector will have a gain of four within the field of view shown, except for a "shadow" in the center, where the gain will drop as low as three. The angular size (θ) of this shadow is given by the expression: $\theta = \arctan r/d$. Gain also drops quite rapidly at angles outside the design field of view. For a desired field of view (FOV), the pipe distance (d) and the mirror width (s) are:

$$d = \frac{\sqrt{2}\, r}{\sin\,(45^\circ - FOV/2)}$$

$$\text{and } s = \frac{d \cos\,(FOV/2)}{\sin\,(45^\circ - FOV/2)}$$

The bottom diagram and chart show how to design a high-gain flat-mirror collector. Like other high-gain collectors, this has a very narrow field of view. And mirror quality (reflectivity, R) is more important due to the multiple reflections of the outer rays. Optical gain (G), where ϕ is mirror angle, is approximately:

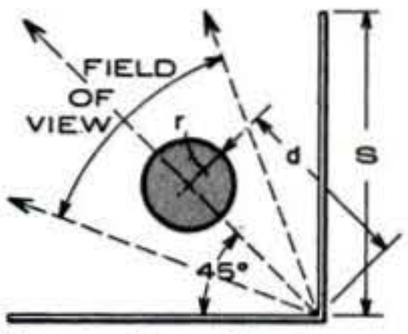
$$G = \frac{R + R^{(90^\circ/\phi)}}{2 \tan\,(\phi/2)}$$

Mirror width (s) is:

$$s = \frac{r}{\sin^2\,(\phi/2)} - \frac{r}{\sin\,(\phi/2)}$$

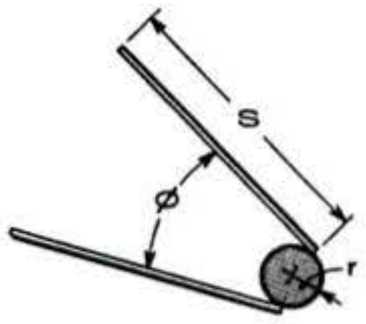
Making the mirrors wider than this will not improve solar gain.

These flat-mirror designs offer the potential for very low-cost construction, perhaps using coated mylar film stretched over Styrofoam forms for both support and insulation. Such construction could eventually make flat mirrors the solar collectors for your home or business. But why wait? With two mirrors, a piece of black pipe, and a glass or plastic cover, you can test for yourself. PS



Wide-angle collector

Field of view	d, pipe distance	s, mirror width	θ, central shadow
50°	4.1r	11r	27°
55°	4.7r	14r	24°
60°	5.5r	19r	21°
65°	6.5r	25r	17°
70°	8.1r	38r	14°
75°	10.8r	65r	11°
80°	16.2r	143r	7°



High-gain collector

ϕ, mirror angle	s, mirror width	G, optical gain: R = 0.98	R = 0.90
30°	11r	3.6	3.1
25°	17r	4.3	3.6
20°	27r	5.4	4.3
15°	51r	7.1	5.5
10°	120r	10.4	7.4
5°	500r	19.2	12.0

About the author:

Mr. Miller is a research physicist at the U.S. Army Missile Command, Redstone Arsenal, Ala. He has worked in optical-guidance technology since 1964, and has 19 patents.

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Buried bookstore

saves energy, saves space, saves the view

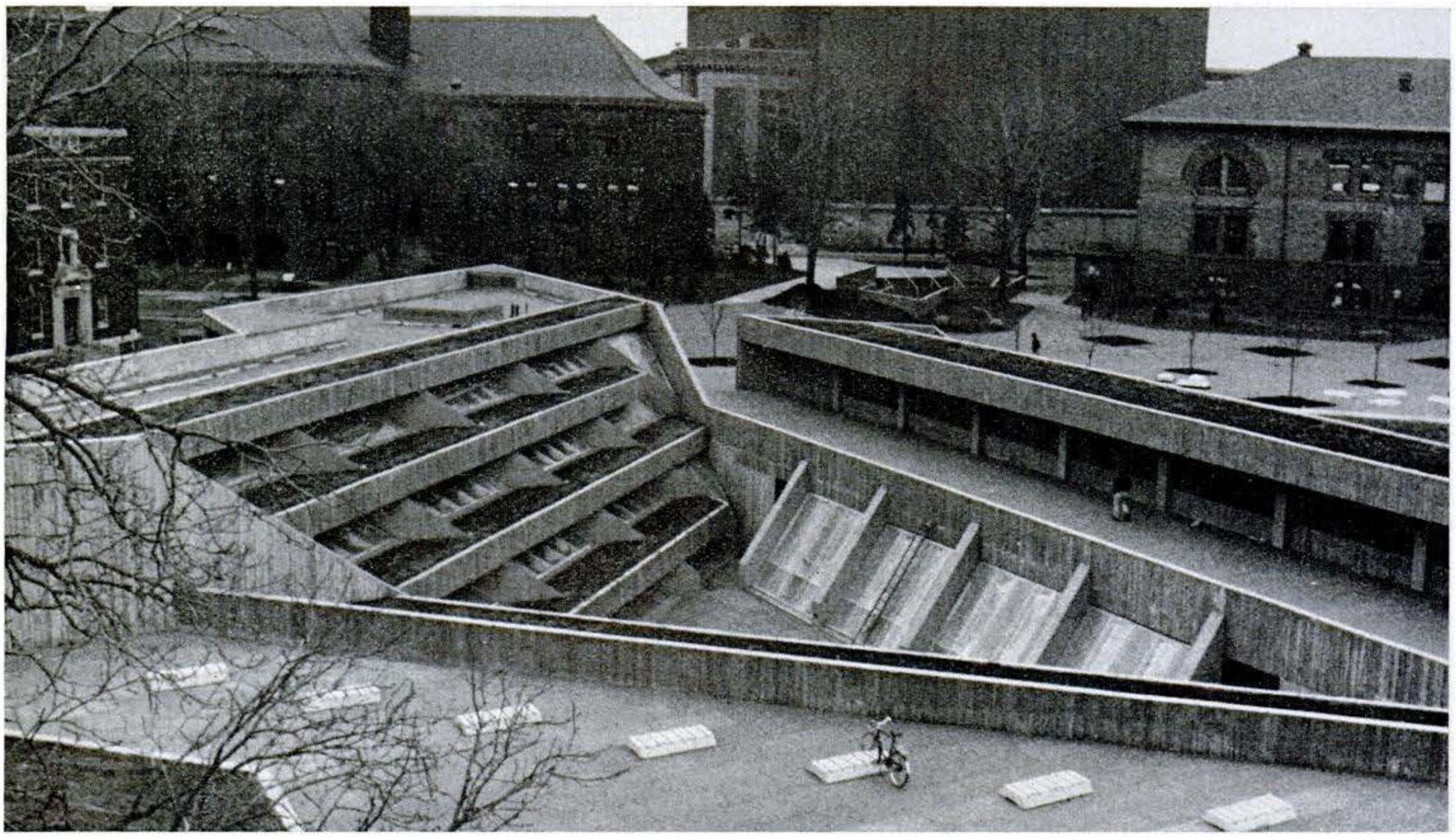
By SHARON J. MARCOVICH

Inside, angled windows admit a view of sunlit terraces landscaped with juniper and ivy, belying the fact that you are 26 feet below ground, and that the roof soaring above you is actually a courtyard traversed by thousands of people.

In fact, people and their comfort, both physical and psychological, were primary considerations when Williamson Hall, the new bookstore and admissions and records facility at the East Bank campus of the University of Minnesota, was first conceived by David Bennett, director of Myers and Bennett, Architects/BRW, and also vice-president of BRW, Inc., design consultants for the project.

But there was another critical consideration: energy conservation. In the harsh climate of the Twin Cities, efforts at saving energy are more than an academic exercise.

Ultimately, to preserve the view of venerable Folwell Hall to the north, and to spare traditional patterns of campus circulation, the designers decided to depress 95 percent of the new building into the ground. Most of its roof begins about two feet under the surface and the lowest floor is at about 45 feet. Energy conservation is intrinsic in a structure built down rather than up [see "Underground Houses," PS, April]. At 10 feet, the soil temperature in Minneapolis stays at about 50° F throughout the year—while air temperature varies from −35° to 95°. Thus, assuming the interior is maintained at 68°, the inside-to-outside temperature



Mostly underground, new bookstore doesn't interfere with campus traffic, preserves limited open space. Building won design awards from *Progressive Architecture* magazine and from American Society of Landscape Architects.

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difference is cut from as much as 100 degrees on a really cold winter day, to a mere 18. The bookstore is so easy to heat, in fact, that during the day, when it's full of people and lights are on, no other heat is required, unless the outside temperature plummets to −20° F. Even on those really cold days, and at night and when the building is empty, not much heat is required, because an underground building retains heat very effectively. Most of the heat that is needed will be furnished by the sun.

Sun power

Dr. Thomas Bligh, assistant professor of mechanical engineering and civil and mineral engineering, and Dr. James Ramsey of the mechanical engineering department at the university, have a $93,000 grant from the Energy Research and Development Administration (ERDA) to design a solar heating —and cooling—system for the bookstore. The system they've come up with uses Slats concentrating collectors manufactured by Sheldahl of Northfield, Minn. The collectors will heat water to 250° F, and store it in an 8000-gallon tank. Only 6600 square feet of the tracking collectors will be used for the 84,000-square-foot building.

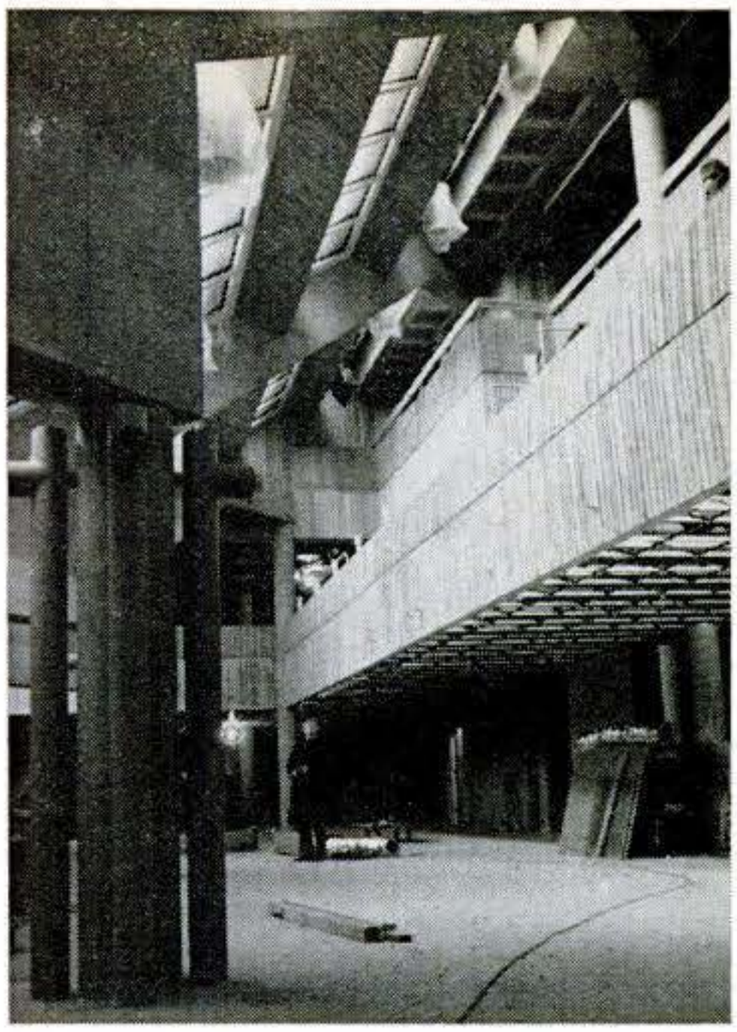
The primary function of the solar collectors will be to supply hot water to run an absorption air conditioner [PS, Sept. '75] for summer cooling. The solar system is expected to supply more than 50 percent of the building's heating and cooling needs. A steam system is provided as backup.

The bookstore will also collect solar heat passively. South and west windows that look out on a triangular sunken courtyard transmit direct sunlight in winter. To keep out the hot summer sun, a series of louvers, actually large continuous planters, are placed in rows outside the windows. These are designed so that the low winter sun (at about 22° in Minneapolis) can shine in, but the high summer sun (at about 68°) can't penetrate far. Deciduous plantings further enhance the effect.

Other energy-conserving features include a heat-recovery system that removes heat from exhaust air and transfers it to intake air, and bright lighting for work areas and low general lighting, all within a matrix that allows the fluorescent fixtures to be easily moved. A low-pressure air-handling system provides fresh air for the building, which is divided into zones that can be controlled separately. This avoids the need for a high-pressure fan and duct system.

Construction

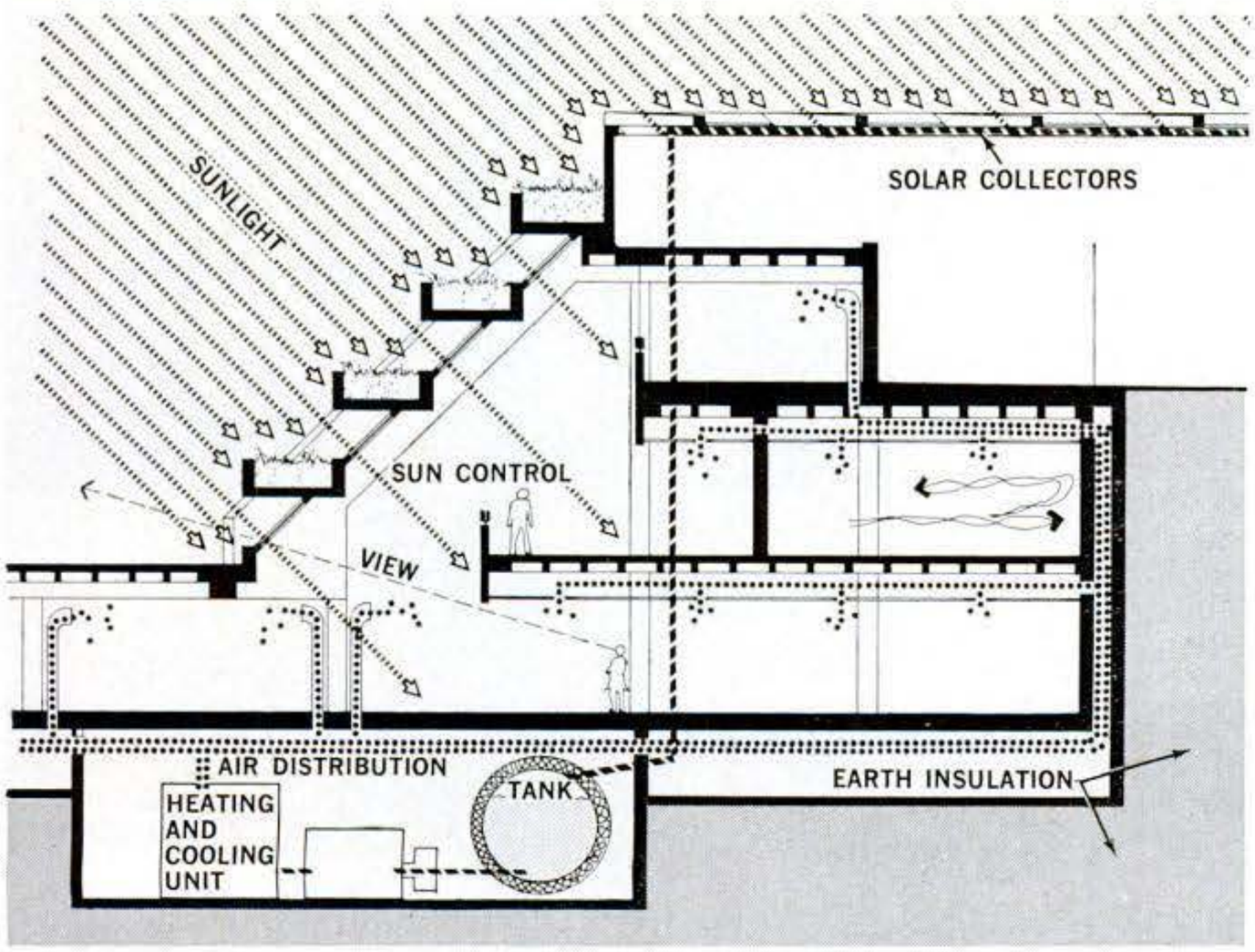
Poured, cast-in-place concrete was used for economy, and because its plasticity was ideal for the design's complex geometry. The material, indeed, seems to flow—on the heavily ribbed exterior walls textured like the bark of a weathered tree, on the smooth pillars and inner walls, on the sandblasted ribs of the structure. The roof is covered with a waterproofing rubber membrane and two inches of Styrofoam insulation. Styrofoam also covers the walls to a depth of four feet—below the normal frost line. Walls are waterproofed with liquid Silastic rubber painted on by hand.



Interior is bathed in natural light even two stories underground, since upper floor is treated as mezzanine. Pipes in foreground are "air fountains," outlets for low-pressure ventilation system. Architect Bennett stands in rear.

Unlike most energy-saving buildings, the underground bookstore was built at the cost budgeted for a conventional above-ground structure. Savings were realized because only five percent of the outside requires finishing, and because much of the insulation comes from backfill of the free earth.

The backfill used wasn't only that dug from the site. Dr. Bligh has a $242,000 National Science Foundation grant to monitor the building's heat-loss characteristics. To make the data valid for underground construction throughout most of the country, he's using five different types of soil as backfill material. The results of these measurements, plus lab tests and computer studies, will eventually become the heating and cooling standards for underground buildings to be published by ASHRAE, the American Society of Heating, Refrigeration, and Air-Conditioning Engineers. PS



Solar heat is collected passively by south- and west-facing windows; heat from concentrating collectors goes to storage tank. Collector array consists of 10 curved mirrors 12 in. wide by 20 ft. long; each focuses the sun's rays onto a single copper tube. Hot water (at 250°F) supplies heat for building when needed and runs absorption A/C in summer. Only five percent of floor area is above ground, but 34 percent of the heat loss from building is from the section that is exposed above grade.

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What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

Solar cells stretch Honda's fuel

Park this modified Honda CVCC in the sun for eight hours; its rooftop solar-cell panels charge six six-volt batteries with enough energy for a one-hour drive. Top speed on batteries is 25 mph. Two electric motors and the batteries are located in the luggage compartment. When the batteries lose their charge, owner Wallace Moore turns the ignition key to the left and starts the Honda's gas engine. Moore (center) is flanked by officials from Sensor Technology, Inc., the Chatsworth, Calif., firm that supplied nine 10.6-watt panels.

Double time

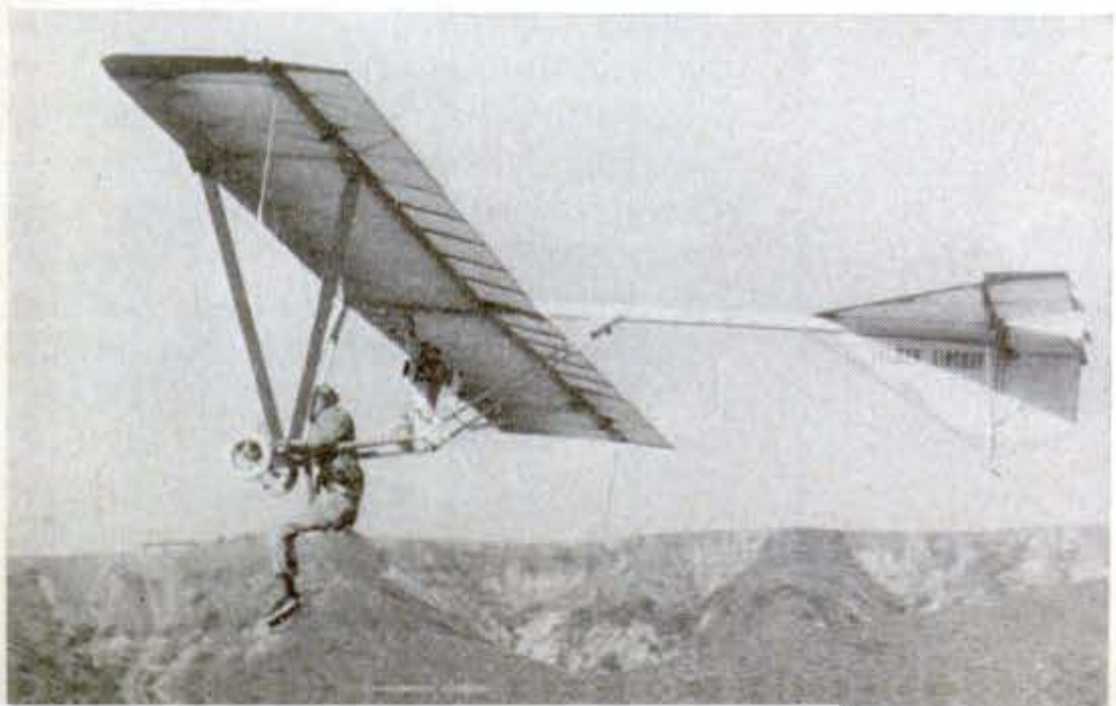
Two liquid-crystal displays (LCD's) provide both time and stopwatch functions in Heuer's $325 Chronosplit. The upper LCD gives hours, minutes, date, and month. The lower display shows hours, minutes, seconds, and hundredths of a second. There's a built-in light, too.

10-hp glider

You can launch the Sunfun VJ-24E from level ground and fly uphill to hang-glider departure sites. It has a 10-hp engine. And after a flight, there's no need to disassemble this glider to haul it back to a hilltop. Volmer Aircraft, Box 5222, Glendale, Calif. 91201.

Flying cat

A sophisticated wingsail boosts windward performance of this 25-foot, class-C catamaran. The adjustable trailing edge flaps optimize the airfoil shape. The boat, built by artist Jim Hansen of Atherton, Calif., weighs only 550 pounds.



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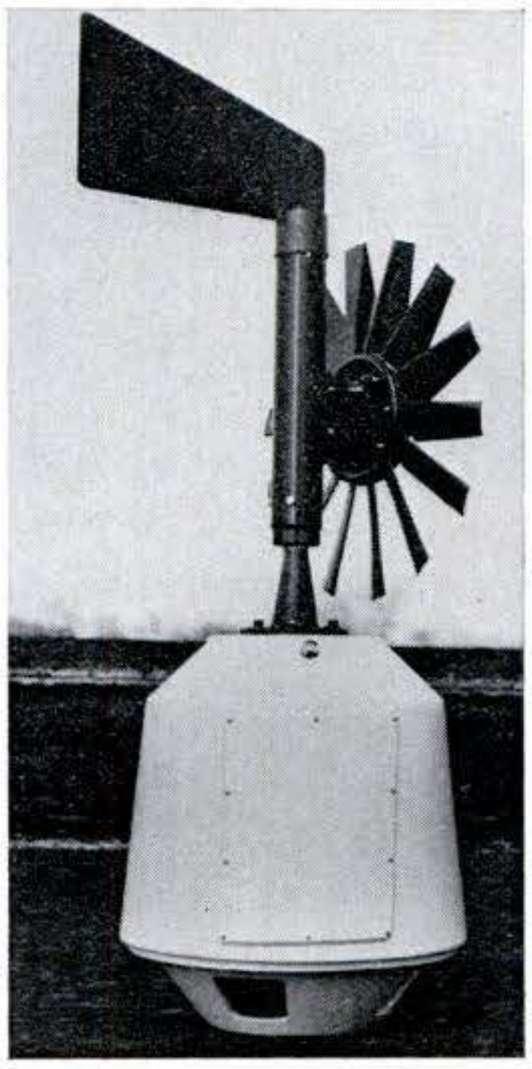
Rechargeable light

A rechargeable nickel-cadmium battery in the Tekna-Lite flashlight provides the brightness of four D cells, says the maker. The light, designed to stay dry 300 ft. underwater, comes with a 110-volt charger. Price: $29.95. Tekna, 3549 Haven Ave., Menlo Park, Calif.

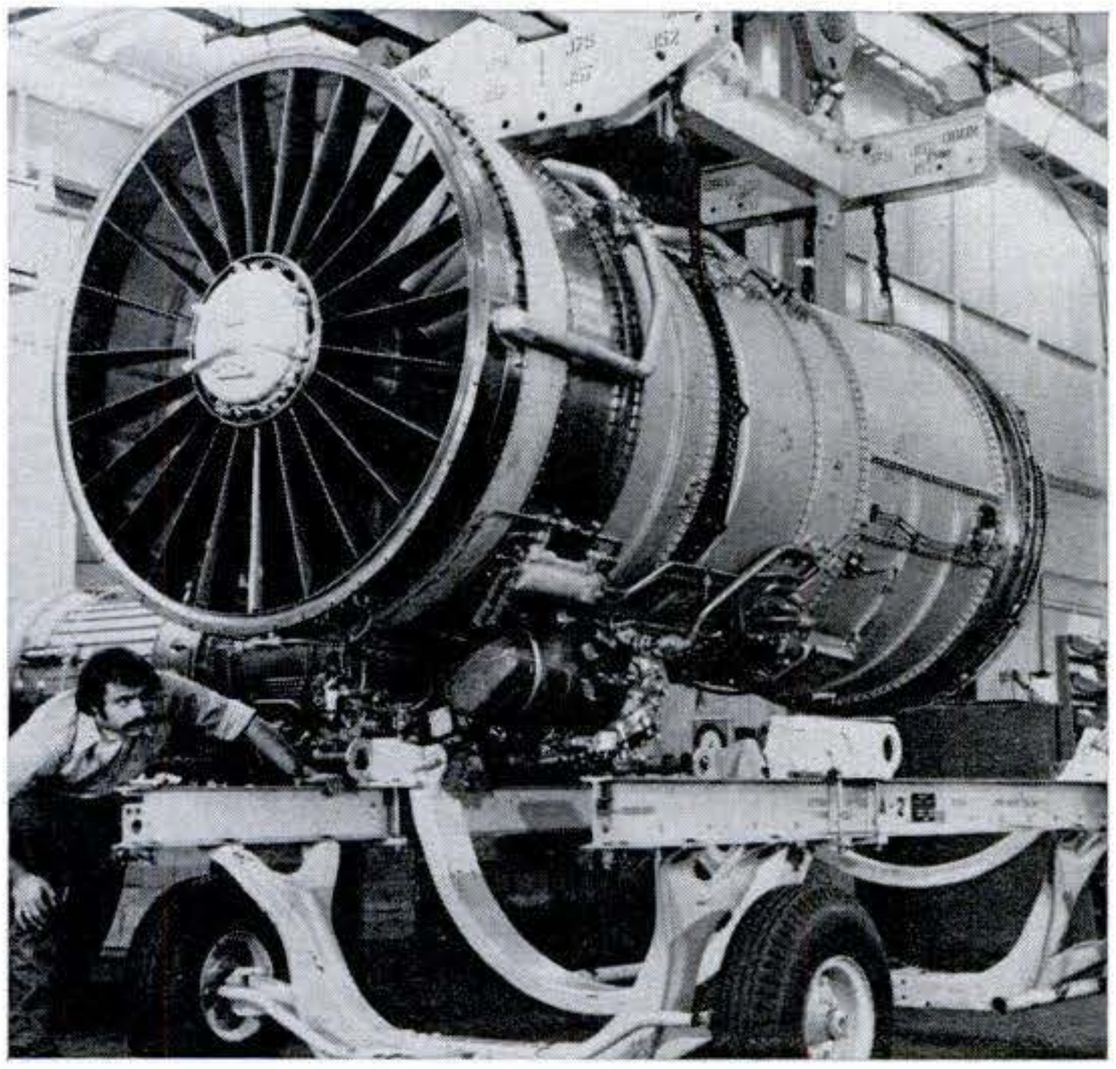


Wind-powered buoy

A wind-powered 50-watt alternator in this British-made buoy charges batteries to power marine radio transmitters, radar transponders, and navigational beacons. The 26-inch plastic fan provides maximum generator output at a wind speed of 40 knots.

For the 1980's: AMC's concept cars

Future fuel-saving cars at American Motors dealers should look like these experimental-design Concept 80 models. Concept Electron (top) is a three-passenger electric commuter car based on an earlier AMC lithium-battery vehicle. Concept II (center) carries six, has a short hood and expanded glass area for good visibility, concealed headlamps, and soft bumpers for damage protection. Concept AM Van (above) is a go-anywhere vehicle when it's equipped with four-wheel drive. The van has Cibie off-road lights, "sidewinder" exhaust pipes.



Jet engine

Less noise and lower fuel consumption—that, says Pratt & Whitney, is what its new JT8D-209 jet engine offers. The high-bypass-ratio 209 engine delivers a thrust of 18,000 pounds. It's being tested in the YC-15 STOL transport.

Super boot

Cold weather chill your feet? An experimental boot being tested for the Army keeps feet warm and dry at —40° F. Uniroyal made the lightweight boot by injecting polyurethane into molds. A scaled-down version for civilian use is being test-marketed.

Nosey aircraft

The huge nose on this Hawker Siddeley Nimrod protects a radar aerial designed to detect numerous air and surface targets over a wide surveillance area. This military version of the Comet airliner has another giant radar at the tail.

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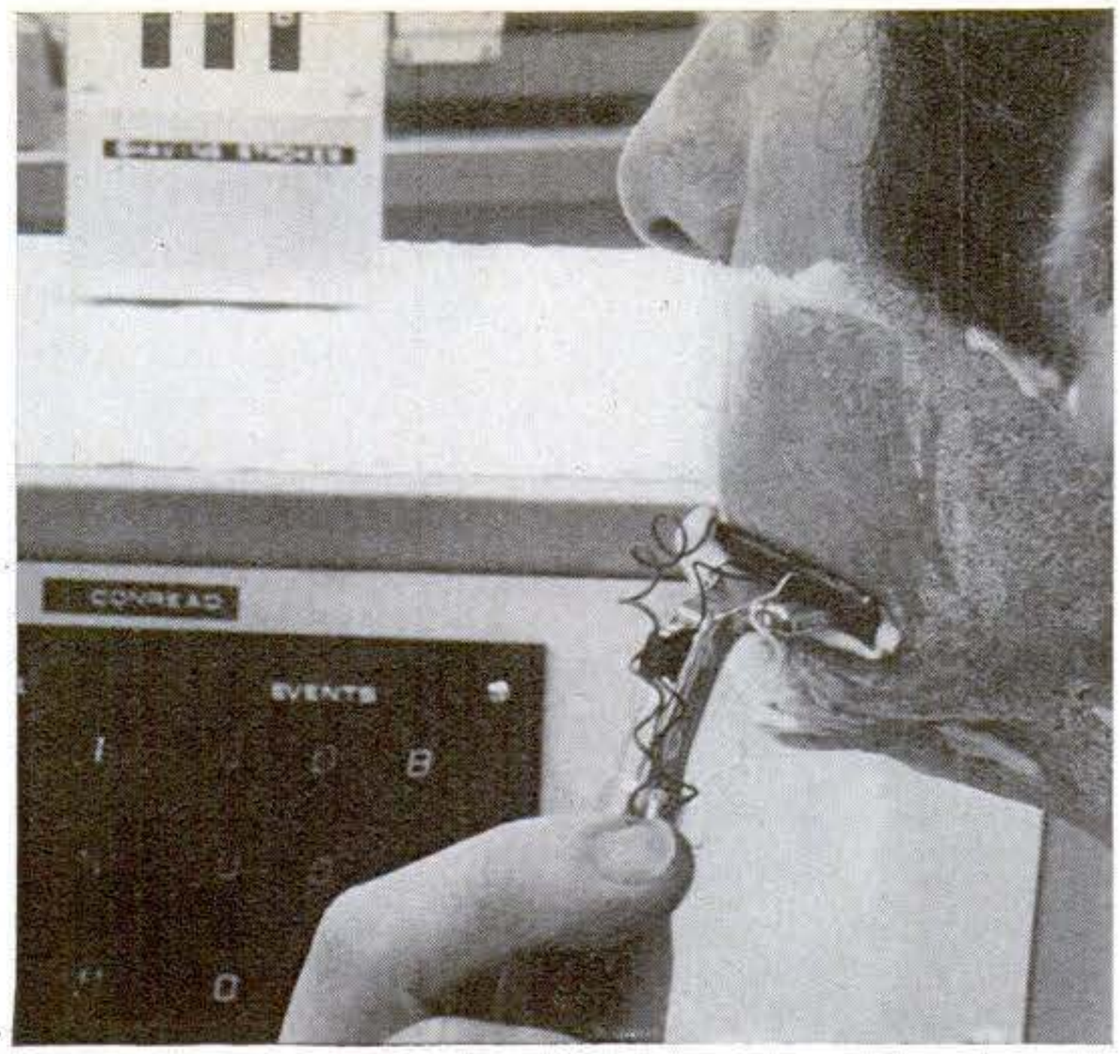
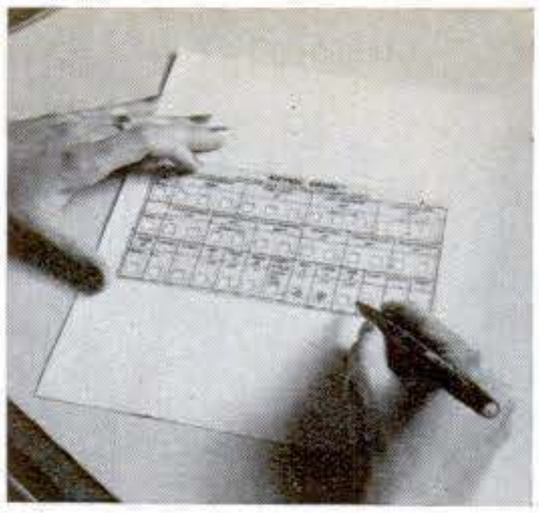
What's New



Rotating razor

A shaving scientist tests the face-hugging capabilities of Gillette's new ATRA pivoting-head razor. An electronic counter measures how blades follow skin contours. Gillette says that the ATRA has 10 percent better skin contact than its Trac II. Price: $4.95.



Metric aid

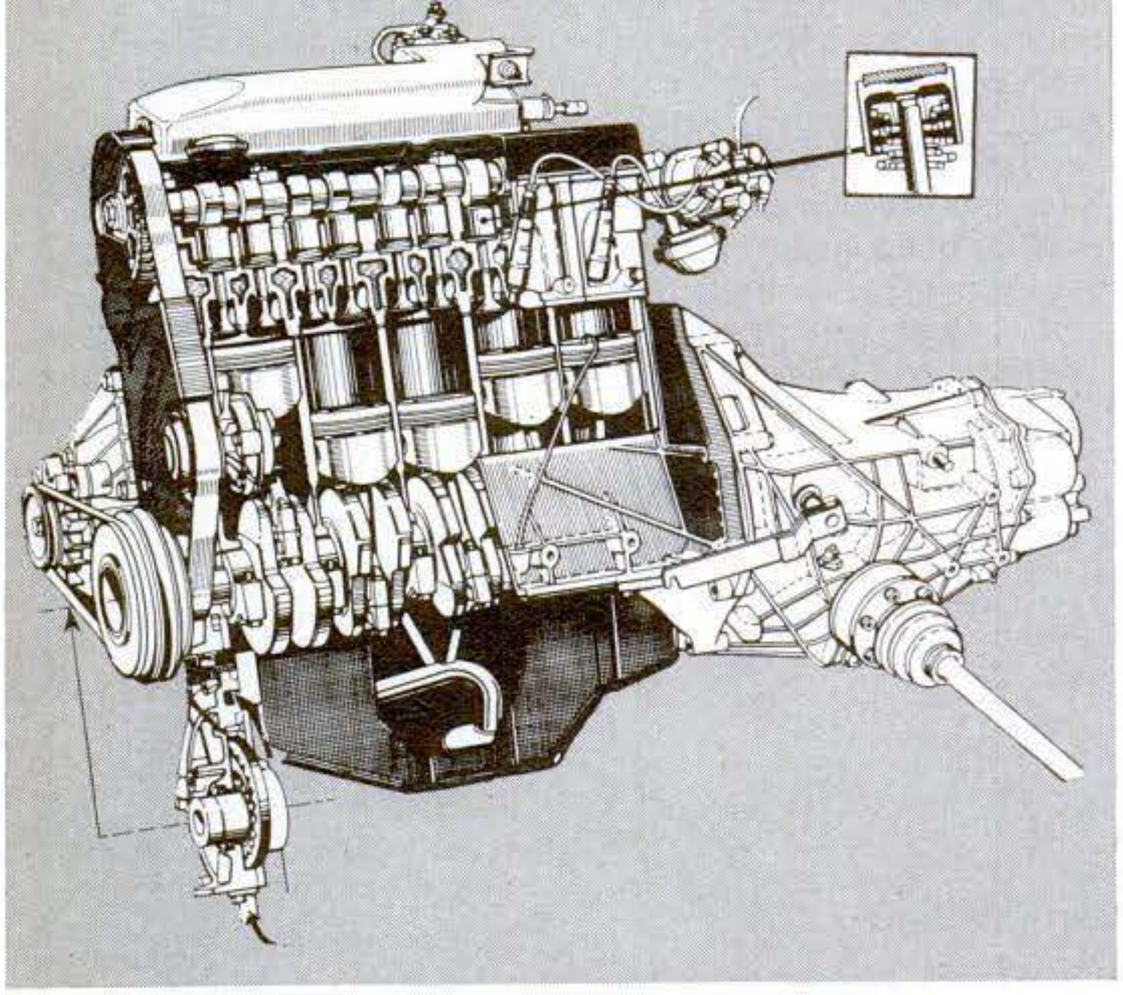
Conversions within the metric system are easy—*if* you remember the prefix meanings. With the Metric Genie you just enter the figure, put a decimal point under the new prefix, and fill in zeros. Metric Genie, Box 305, Corte Madera, Calif. 94925. Price: $3.

Vegetable peeler

Want to speed up salad making? GE's Peeling Wand may be the answer. The electric peeler strips most fruits and vegetables, including tomatoes. An "eyer" tip cuts out blemishes, and a spatter shield helps contain peelings. The sealed unit can be used underwater. Price: $23.

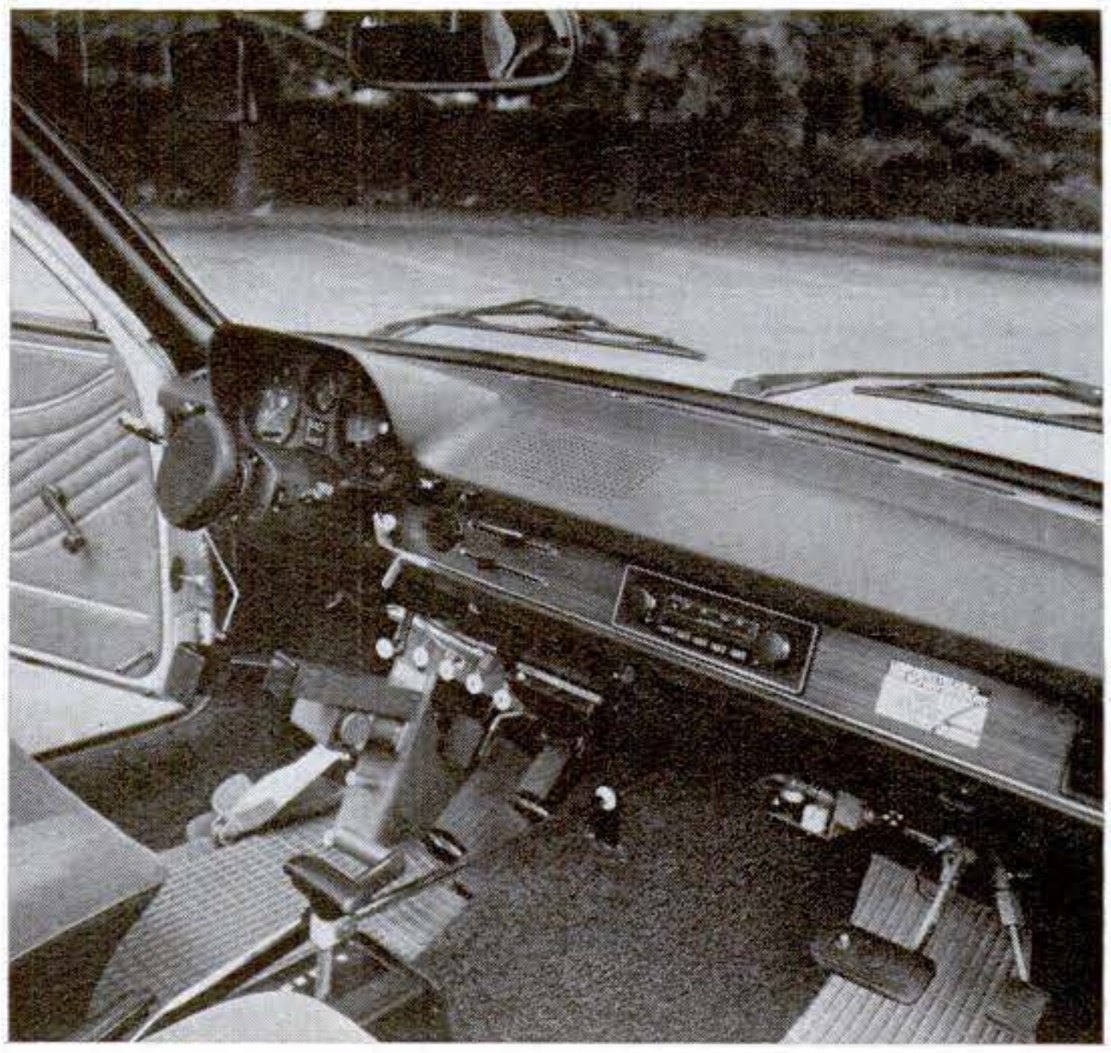
Foot-controlled car

There's no steering wheel on the VW Dasher (below) because it's designed for armless drivers. Foot controls include an ignition pedal (far right) and an engine cutoff (far left). Pressure on the flap-like pedal steers the car. The Sharpe Health Institute (Wash., D.C.) is testing it.



One-of-a-kind engine for Audi

A unique engine gives the new Audi 5000 more power and smoothness than the Audi 100 it replaces. The front-drive 5000 features an in-line, five-cylinder engine—the only gasoline-fueled five available today. The fuel-injection engine develops 103 net hp, giving the car a top speed of more than 100 mph. Reinforcing ribs added to the engine block and transmission help control vibrations and make for low interior noise levels. The midsize Audi delivers 18 mpg in city driving, 26 mpg on the highway. A fully equipped 5000 will cost about $9000.



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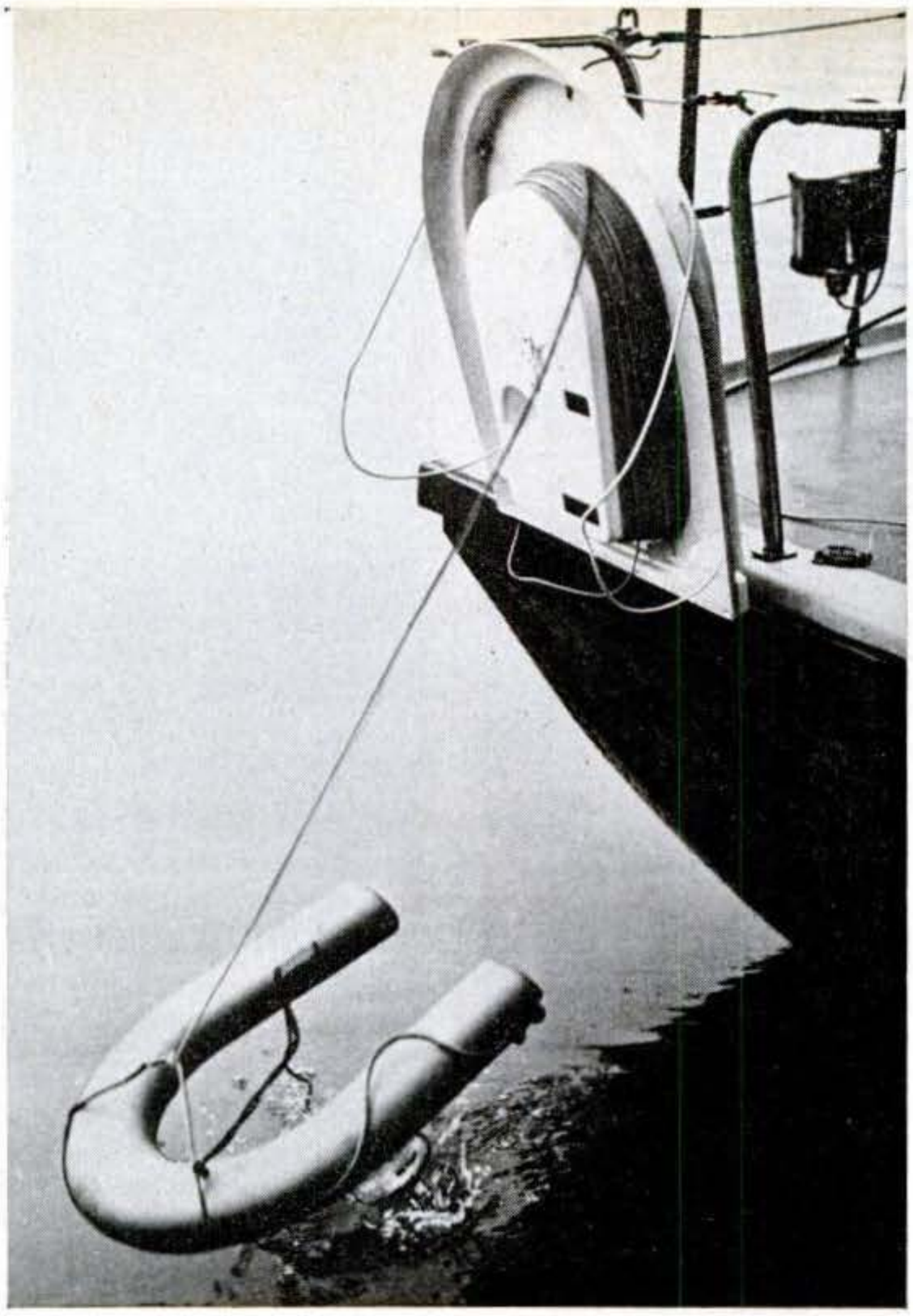
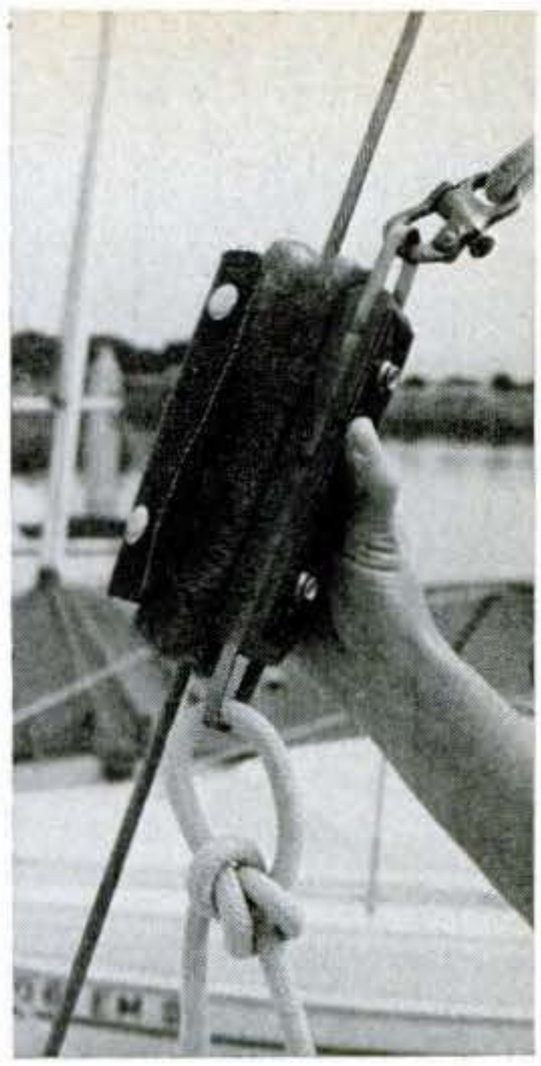
What's New IN BOATING

BY SUSAN RENNER-SMITH



Fast-acting rescue system

Sailor overboard? A new system makes for more efficient rescue, says Mastep Ltd. (Waltham House, Bognor Regis, Sussex, England). A quick-release lever ejects the horseshoe-shaped buoy from its cradle, which holds 200 feet of floating, fluorescent line. When the line is payed out, it separates from the cradle and pulls a six-ft.-tall floating flagpole (not shown) behind it. When the boat comes about for rescue, it heads for the pole and follows the floating line to the horseshoe buoy. The buoy also carries a flashing light and a whistle to help the helmsman and swimmer locate it.

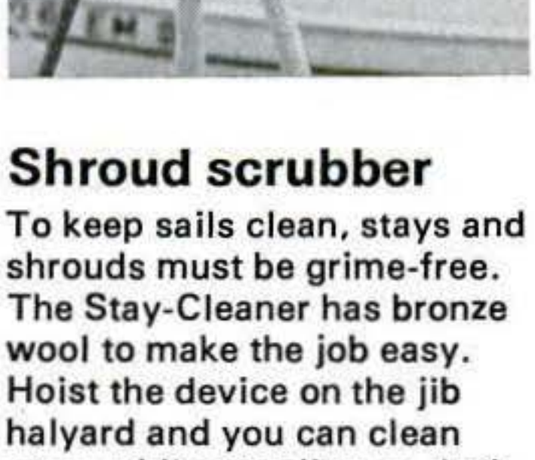


Shroud scrubber

To keep sails clean, stays and shrouds must be grime-free. The Stay-Cleaner has bronze wool to make the job easy. Hoist the device on the jib halyard and you can clean stays while standing on deck. Price: $10 from San Diego Marine, 3618 El Cajon Blvd., San Diego, Calif. 92104.

Bait storage

You can take the tangle out of your bait box with this expandable Junior Bait File. The six-by-10-in. basic unit holds 28 lures, costs $14. A master hinge system lets you add as many 14-lure inserts ($4 each) as you need. Wille Products, Box 532, Brookfield, Wis. 53005.



Easy lifter

One hand lifts your outboard if it's mounted on OMC's new outboard auxiliary motor bracket. A nitrogen-gas-filled spring counterbalances the outboard's weight. The corrosion-resistant aluminum bracket accepts motors up to 15 hp. Price: $90.

Keyboard radio

Crystals aren't needed for access to channels on this VHF-FM unit. Pushing buttons on the back-lighted keyboard gets all marine channels, both domestic and international. The Key/Com 55 is $600. Maker: SBE, 220 Airport Blvd., Watsonville, Calif. 95076.

Bunk bag

Designed to warm a cold bunk, this comforter features a down-filled top and a bottom stuffed with Du Pont Fiberfill II. An attached cover turns it into a bolster pillow for daytime use. It's by Woods Bag and Canvas Co. (Box 118, Ogdensburg, N.Y. 13669). Price: $92.50.

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What's New IN TOOLS

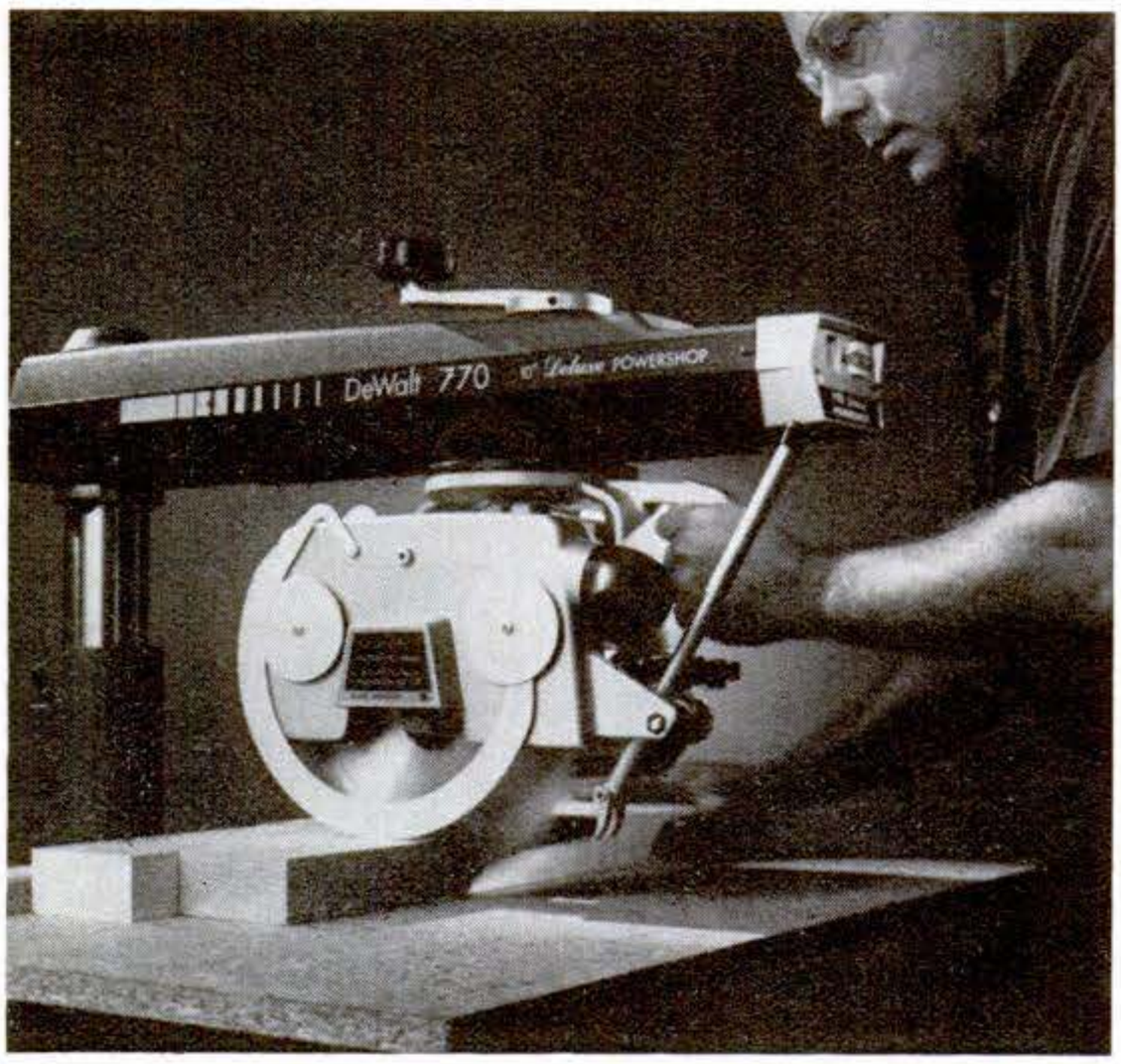
BY R. L. STEPLER

Little drill

You can drill in cramped corners with this compact electric drill from Wahl Clipper Corp. (2902 Locust St., Sterling, Ill. 61081). The tool turns at 9000 rpm, takes bits to 0.123 in. (⅛ in). Two models (6285 and 6275) run on 12 or 110 volts, respectively.

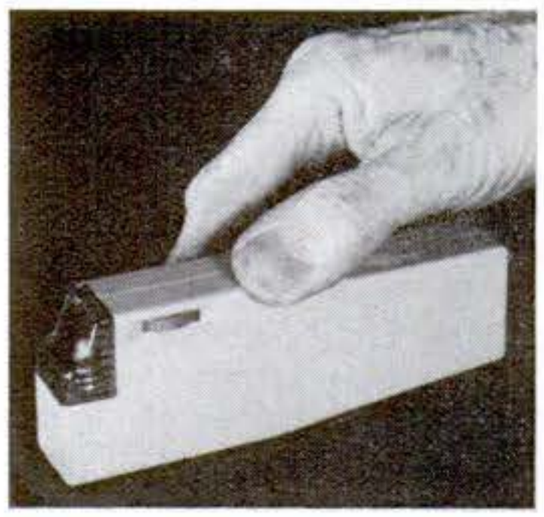
Thixotropic glue

No drips or runs when you apply this water-base contact cement, says Franklin Glue Co. (2020 Bruck St., Columbus, Ohio 43207). That's because of Acrophene, a modified acrylic copolymer, which also gives the cement unmatched holding power, says Franklin.



Wood splitter

Lay in this winter's supply of firewood with the help of the WoodSplitter kit. You get a six-lb. axe with a 36-in. handle, plus a four-lb. steel wedge. Price is $25 from Woodings-Verona Tool Works, Verona, Pa. 15147.

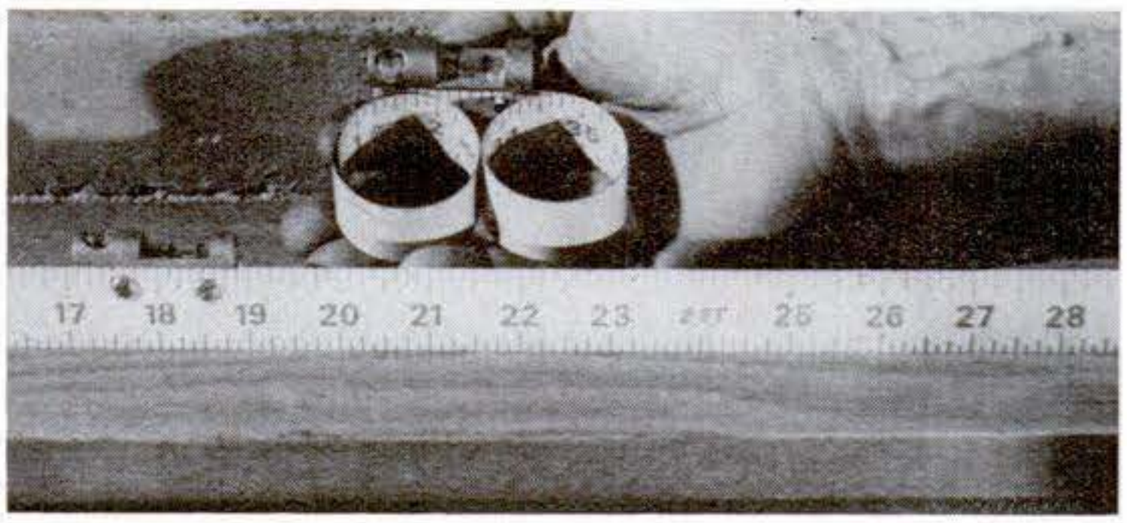


Radial-arm saw

DeWalt's 10-in. Deluxe Powershop performs six basic cuts: crosscut, rip, miter, bevel crosscut, bevel rip, and compound. Model 7775 has a 2¼-horse motor, cuts up to three inches deep. Price: $440. Black & Decker, Towson, Md. 21204.

Metal detector

Battery-powered metal detector lights up to show location of pipes, wires, nails, conduit hidden inside your walls, floors, or ceilings. It's $9.95 from Metrifast, 51 S. Denton Ave., New Hyde Park, N.Y. 11040.



Versatile vise

The D-Vise locks work in any position over a 180° tilt and around a 360° axis. V-grooved jaws hold objects of all shapes up to 2½-in. thick. From Dremel, 4915 21st St., Racine, Wis. 53406.

Little level

Need a level or a plumb but can't lug a three-ft. lunker? This level coils to pocket size, stretches to a rigid 36 in. It's accurate in horizontal or vertical mode. $8.45 from Building Guarantee Corp., W220 N. 3197 Springdale Rd., Pewaukee, Wis. 53072.

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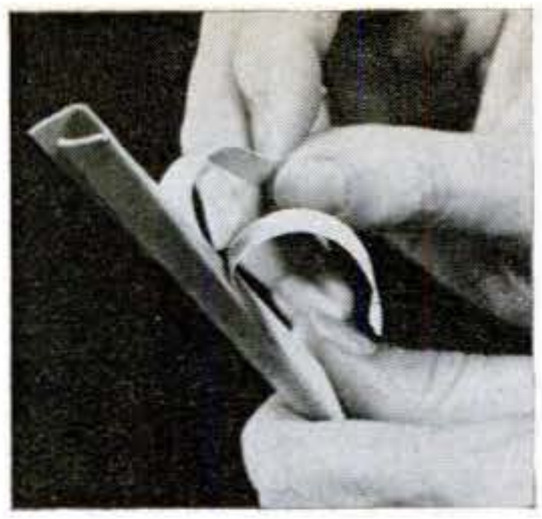
What's New IN HOME IMPROVEMENT

BY R. L. STEPLER



Weather strip

Draft-free doors are yours with Polyflex, a self-adhesive plastic weather stripping. It bonds to metal or wood jambs, can be cut with scissors. Weatherseal Group, Schlegel Corp., Box 197, Rochester, N.Y. 14601.

Gas furnace

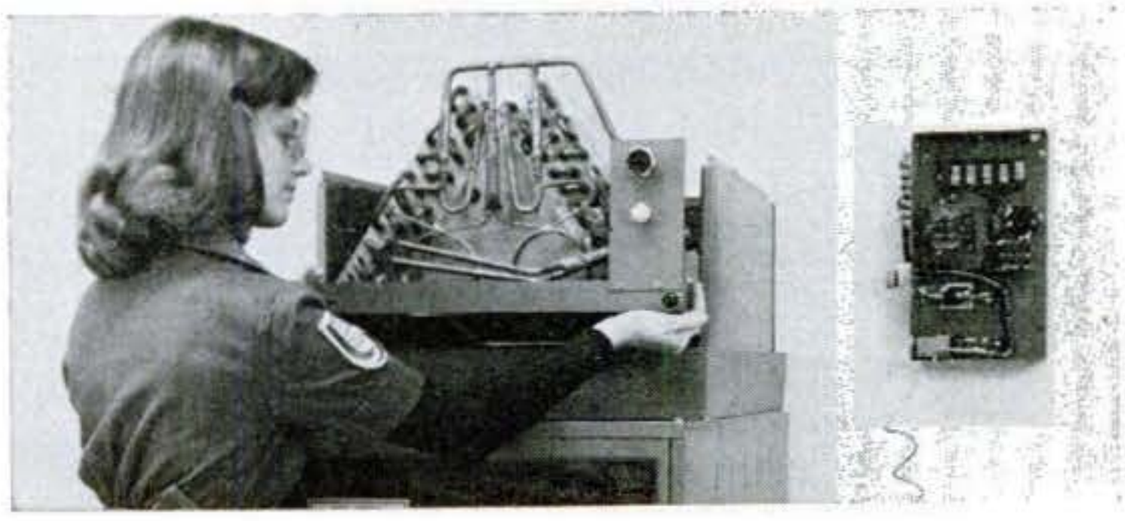
You can cut fuel consumption 20 percent with this gas furnace, claims York. The company's Climaster IV (models from 80,000 to 120,000 Btuh) features electric-spark ignition (no pilot light), plus full cabinet insulation. York, Box 1592, York, Pa. 17405.

Attic vent

Hot air in summer, wet air in winter: Neither belongs in your attic. Automatic power vents get rid of both, says Leslie-Locke (2871 W. Market St., Akron, Ohio 44313). The vents can be installed by do-it-yourselfers.

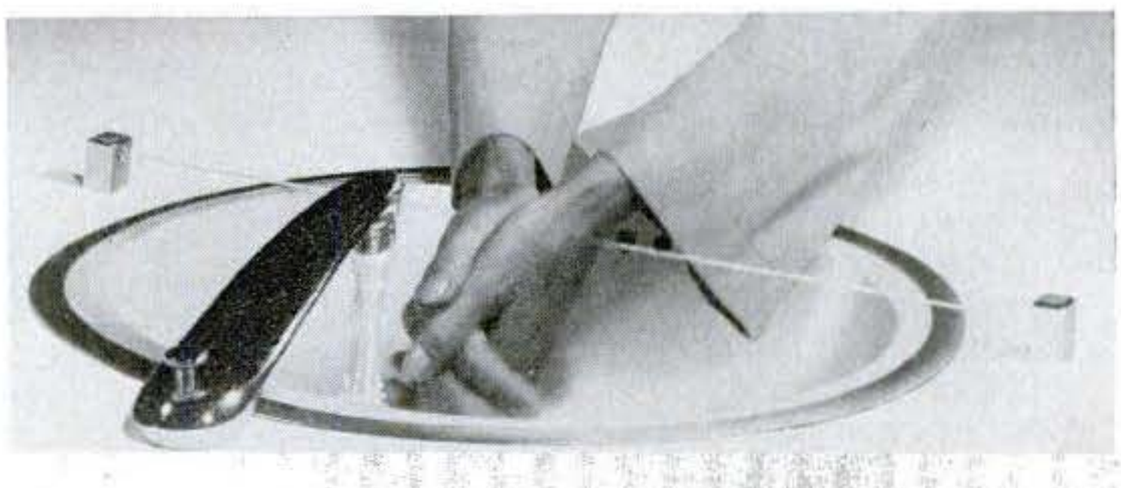
Window screen

ShadeScreen cuts solar-heat gain up to 80 percent, and lets you see out—but others can't see in. That's the claim of Kaiser Aluminum (300 Lakeside Dr., Oakland, Calif. 94643) for this aluminum-louver window shade.



Electric eye

Water flows automatically when Aquatron's electric-eye beam is interrupted. Remove your hands, and the flow stops. You can install it yourself on any sink. Price: $230. Qualco, One First St., Los Altos, Calif. 94022.



Add-on heat pump

Add Maximizer to your existing furnace, says York, and reduce your heating bill 50 percent if you heat electrically, 20 percent if you use fossil fuels. Above 28° F, Maximizer works alone; below 10° F, the furnace works alone; in between, they work together.

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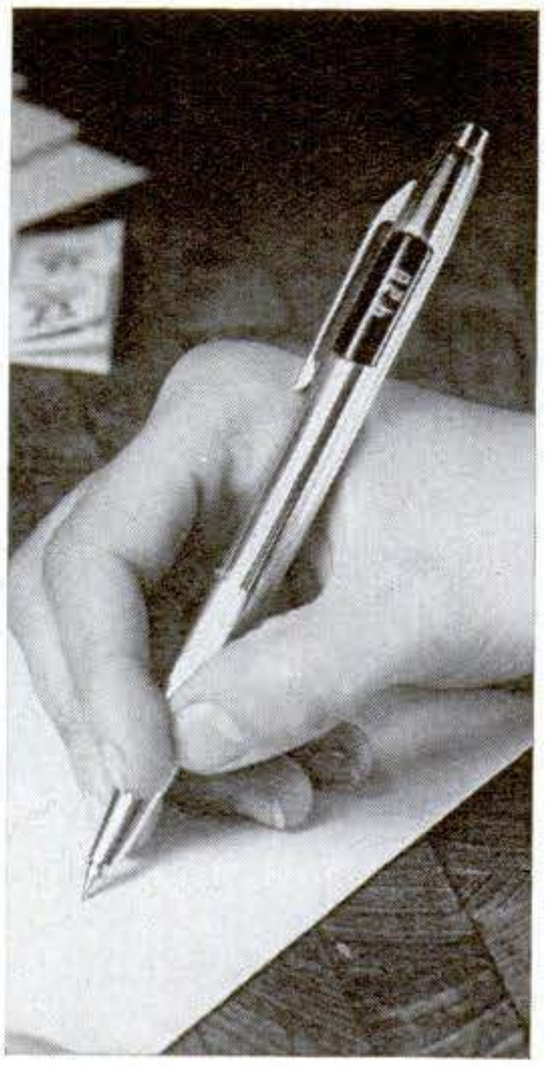
What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS



Ball-point watch

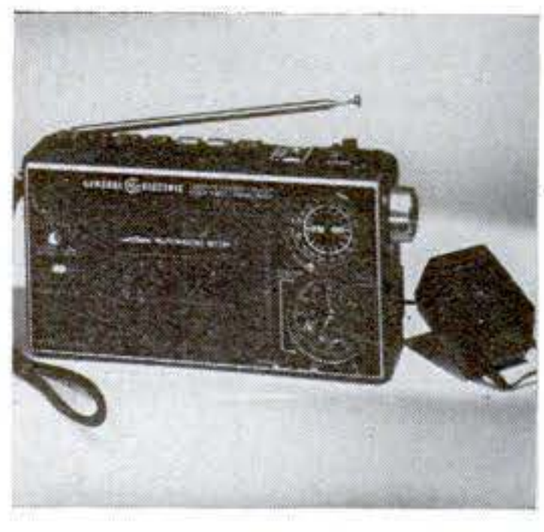
What's the time? Look at your pen. If it's this pen/watch, bright LED's will display the time in hours, minutes, and seconds. It also gives the date. Twist the bottom and a ball point appears. Price: $54.95 From Denson Kelley Associates, 202 Dart St., Hartford, Conn. 06106.

Game / teacher

Connect RCA's Studio II to your TV set and you can play games such as Freeway, bowling, or doodle. But other self-contained functions and add-on cartridges are learning tools. Available at present is an addition game, along with math and social studies. Studio II is $149.95.

TV projector

Hook this box up to an antenna, put a screen in front of it, and you're all set to watch TV—in a big way. This is Advent's new model 10 projection-TV unit, and it produces a 12-foot-square picture using three projection tubes. It's $2595.

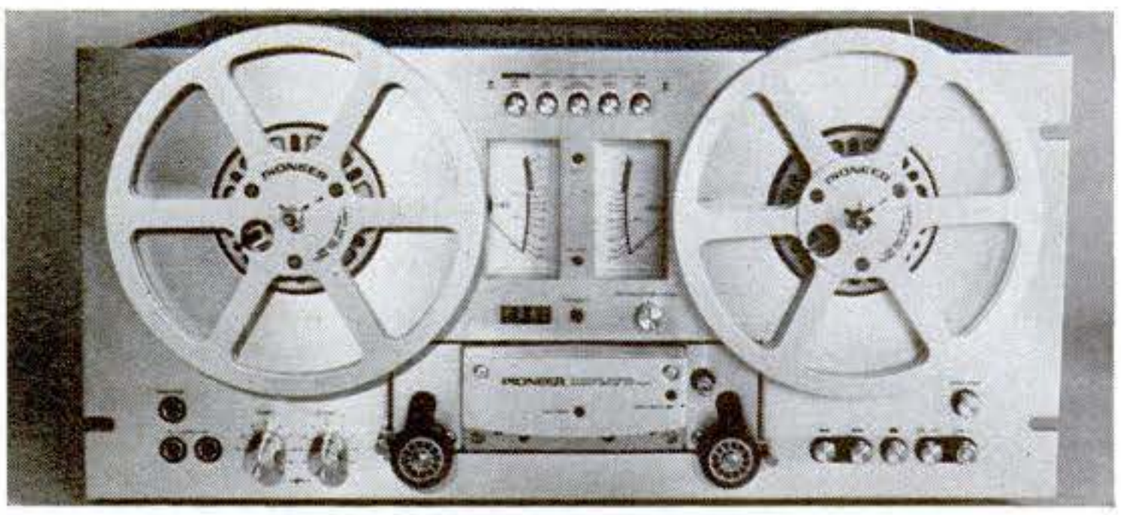


Three-piece CB

Johnson's three-piece CB rig keeps the main electronics package in the trunk for theft protection. The channel-display box and mike are up front with you. All set controls—including 40-channel selector—are on the mike. Johnson American's model 4330 is $199.95.

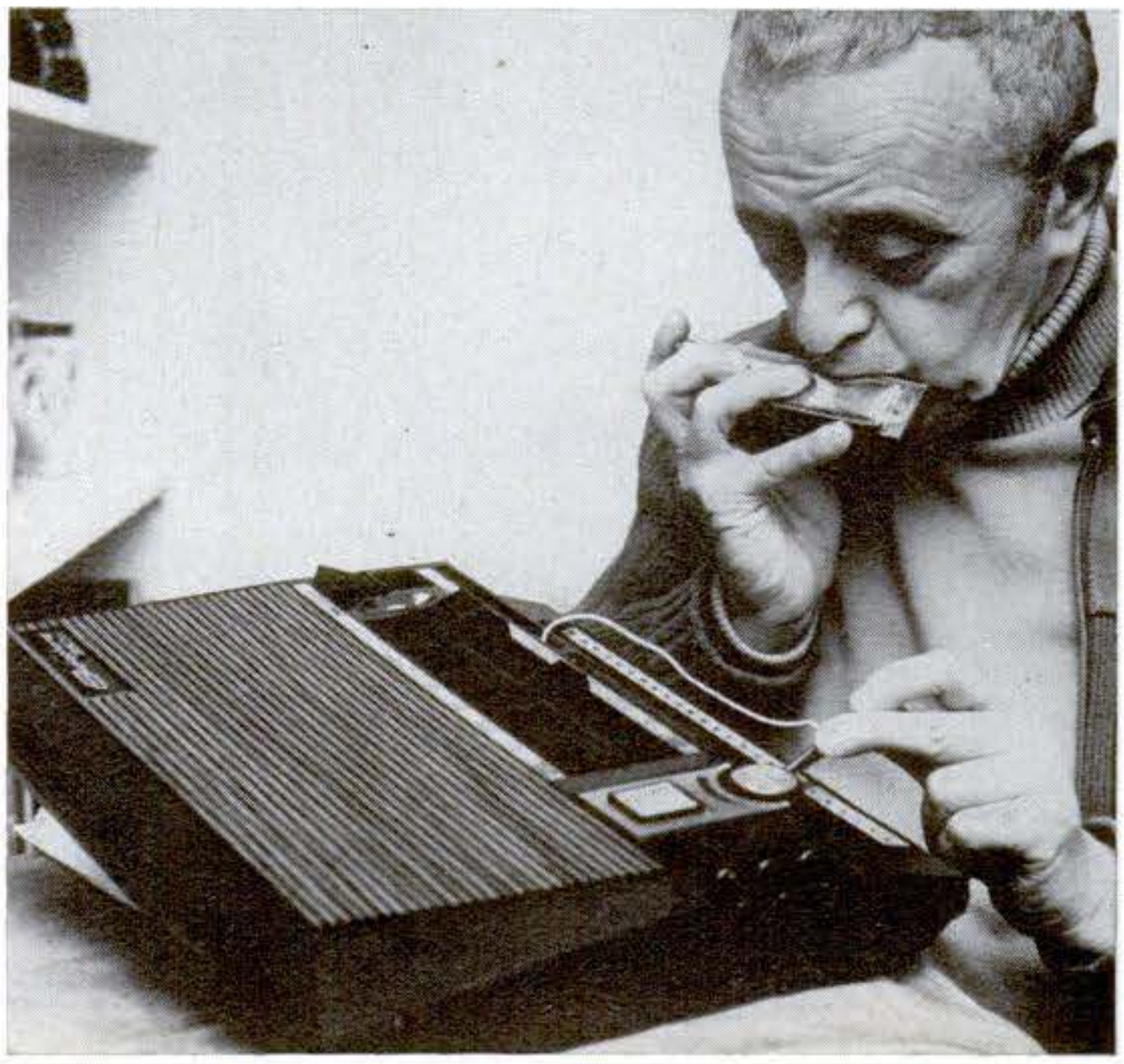
Auto tape / radio

GE's new compact cassette recorder does about everything: It plays an AM or FM station, records it, plays back the tape later if desired. Set the built-in timer and you can wake (or fall asleep) to music or tapes. Model 3-5221 sells for $149.95.



Reel quality

Pioneer has re-invented the reel—and it's loaded with features. Besides specs such as 20- to 28-kHz response, this RT-707 has automatic reverse on playback, dual speeds with pitch control, and bias selection for any tape available. Suggested price is $575.



Synthesizer

Stylophone 350S is no toy. The electronic synthesizer can reproduce the sound of nearly any instrument. In fact, says Audio Arts (5615 Melrose Ave., Hollywood, Calif. 90038), it is used professionally by composers. But a low, unprofessional price buys it: $260.

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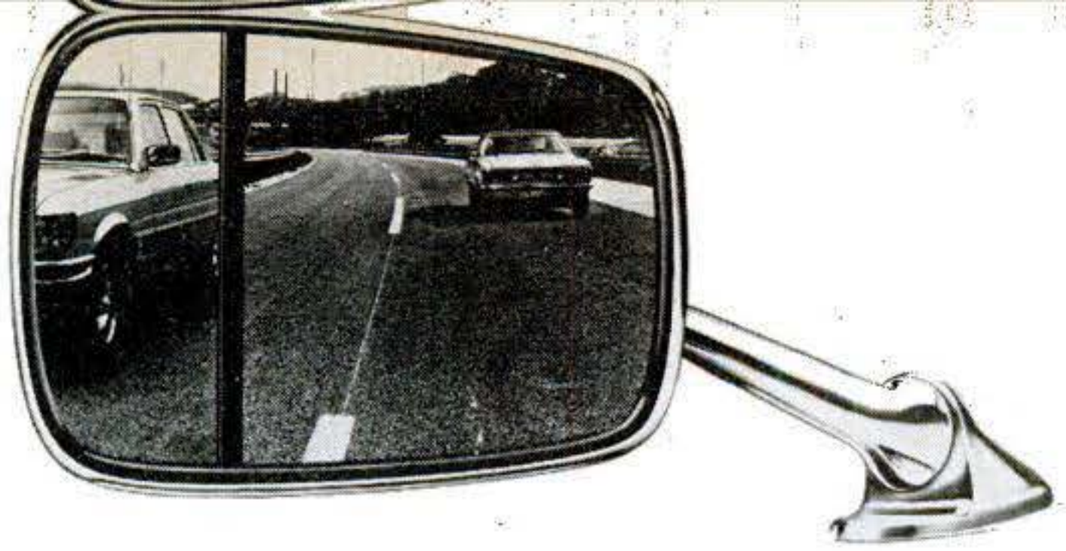
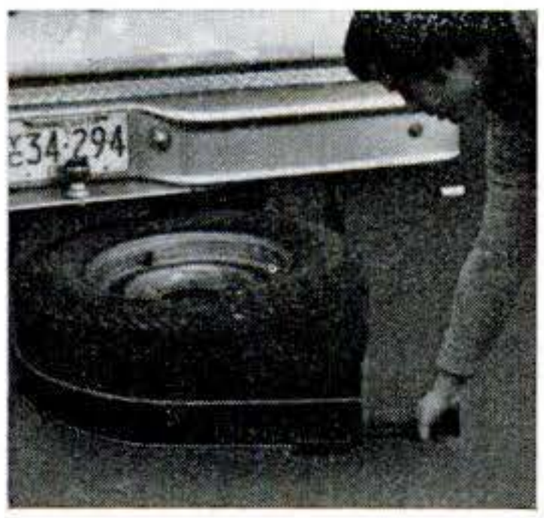
What's New FOR YOUR CAR

BY RICH CEPPOS



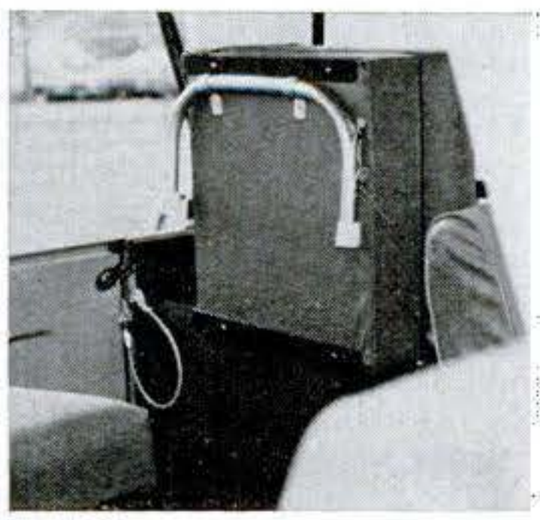
Rear-view mirror

With the Hagus twin-lens mirror, says the maker, you can see cars that are sometimes not visible in a standard side-view mirror. The lens is tinted blue, and mounts on the left or right side. Price: $9.95. A.L.S. Enterprise, Box 447, Jersey City, N.J. 07303.



Tire carrier

Redi-Carrier spare-tire carrier pivots out from under your pickup so you needn't kneel or crawl under the truck to remove the spare. A small hand crank lowers the unit until it pivots out. Price: $139. Fairmont Steel Products, Inc., 1205 N. Dewey St., Fairmont, Minn. 56031.

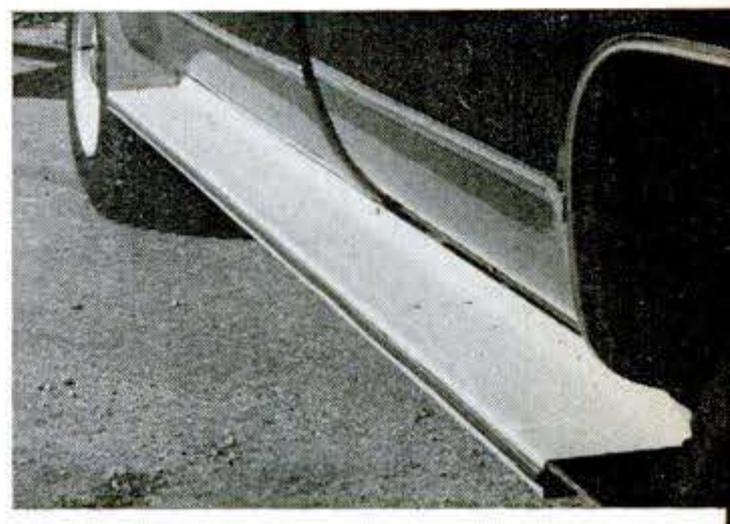


Jeep seats

Fold-up jump seats for the Jeep CJ5, CJ6, and CJ7 flip down to carry up to three people, and fold against the roll bar when cargo space is needed. They're vinyl-covered and foam-padded, and retail for $119.95 a pair. Mountain Man Ind., 1 Delta Way, Grand Junction, Colo. 81501.

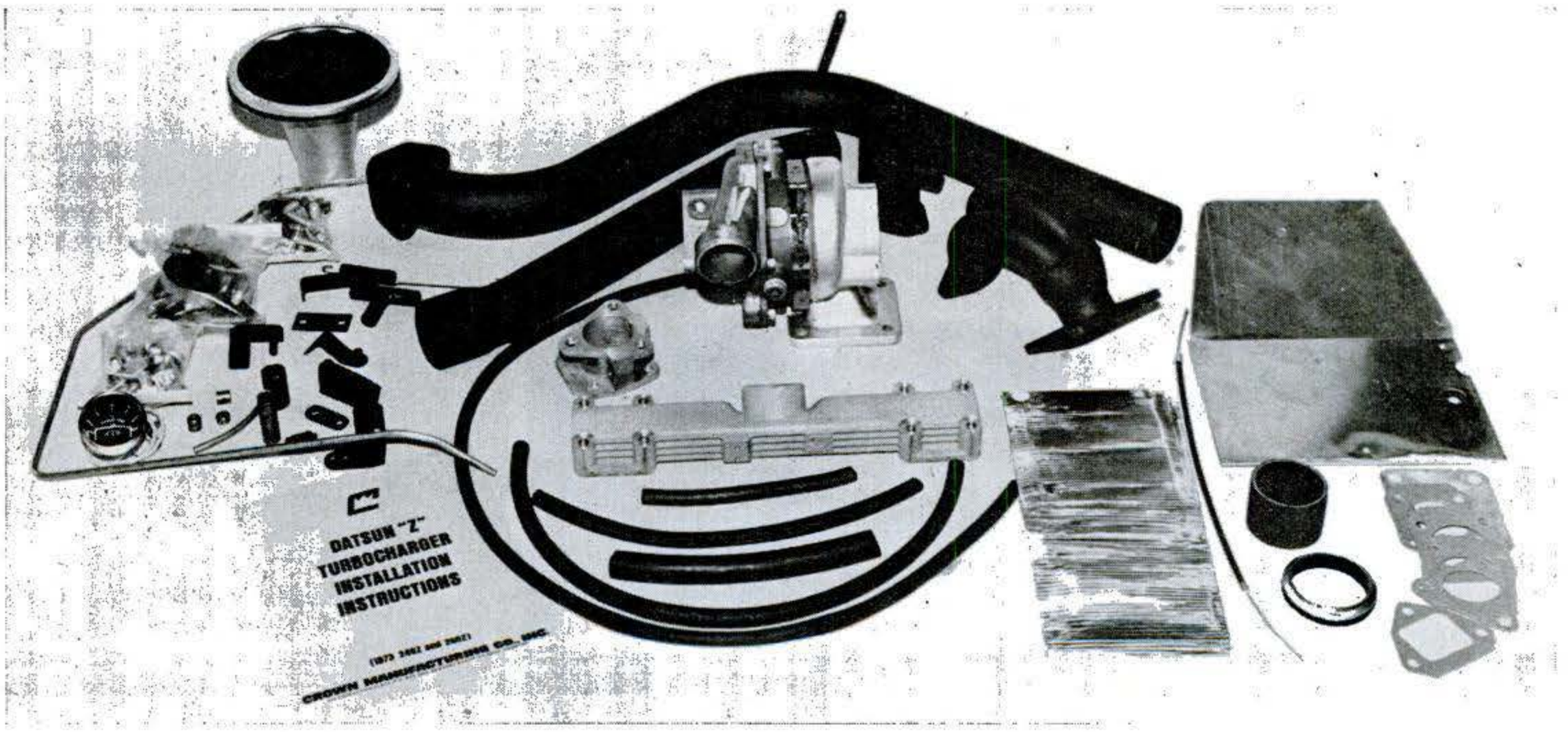
Running boards

Aluminum E-Z Joe running boards look snappy, make access to your pickup's box easier, and protect the lower body from gravel damage, claims the maker. Price per pair is $124 (48 in.), $144 (72 in.), $163 (94 in.). Owens-Classic, Inc., Box 623, Sturgis, Mich. 49091.



Plug-wire puller

Stuck spark-plug wire? The front tabs of the Thexton spark-plug-wire puller grip under the boot, and the jaws grip the boot. Twist and the wire comes off, intact. Puller fits most standard wires. Price: $5.50. Thexton Mfg. Co., 7685 Parklawn Ave., Minneapolis, Minn. 55435.



Turbo kit

You can increase the power of your Datsun 240Z, 260Z, 510 sedan, or pickup by 65-150 percent with a DIY turbocharger kit, says Crown Manufacturing Co., Inc. (858 Production Place, Box 2860, Newport Beach, Calif. 92660). The kit, with hardware, is $680.

Customized sound

The Clarion 100-EQB is a five-band audio equalizer that allows fine-tuning of five separate octave ranges to produce sound custom-tailored to the acoustic characteristics of a vehicle. It's compatible with AM, AM/FM, and tape systems. Price: $129.95.

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Fireproof retreat

One concern haunts any owner of a leisure home in a remote area. When he must leave it far behind, he fears fire even more than those peculiarly American scourges of vandalism and burglary. Fire can wipe out his entire investment, and there's relatively little he can do to protect a conventional home against it. What good is the best alarm system if there's no one around to alert?

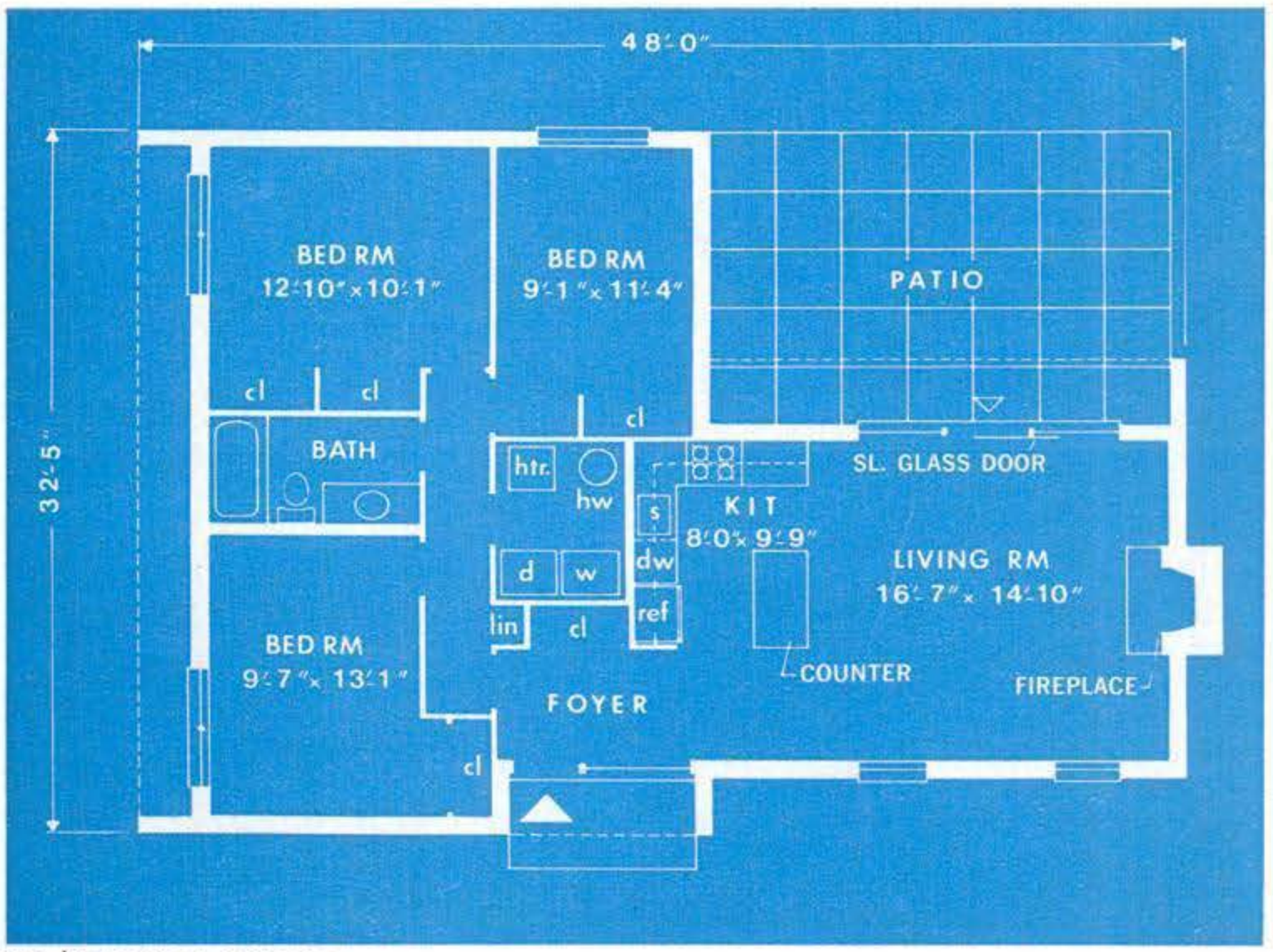
So when architect Samuel Paul offered to design us a snug retreat of noncombustible materials, my only stipulation was that the construction technology stay within reach of the determined do-it-yourselfer. Here's the result: Exterior walls are masonry block; interior facing is fire-coded plasterboard; the roof structure is steel, supporting a fire-resistant decking. Paul assures me that the steel joists and other members can be ordered to exact length to avoid on-site cutting, and that they're lightweight enough for two novice builders to install.

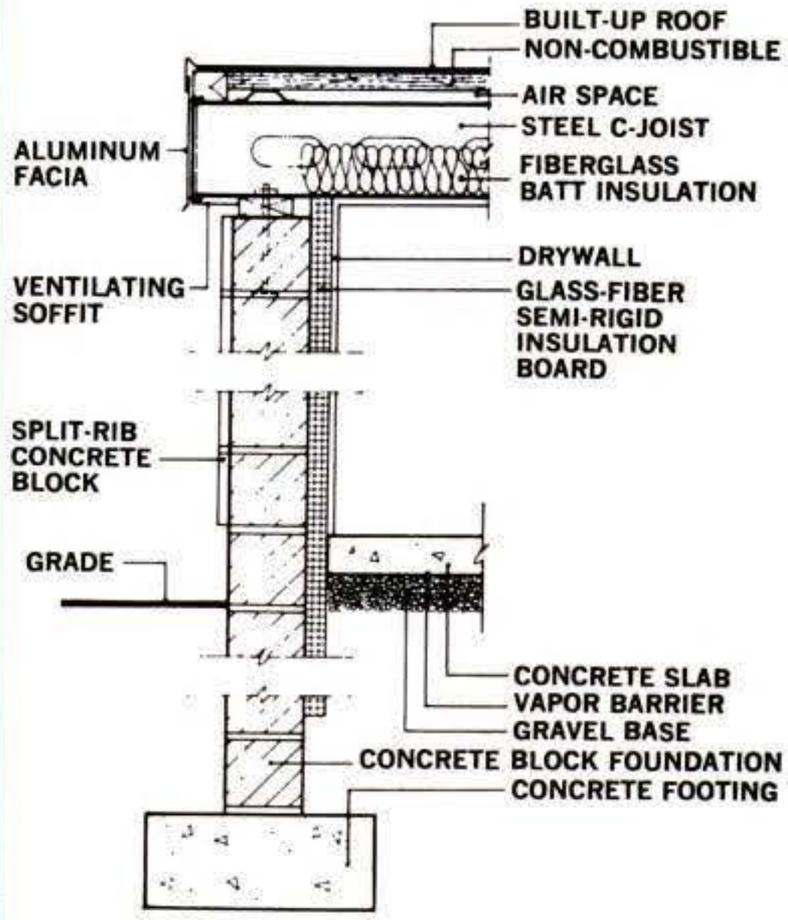
Concrete block can be an easier wall for an amateur to erect than conventional framing—and it sheds its gray prison-wall identity when you use a split-rib block for a textured honeytone effect. The white aluminum edging around the roof slab sets off these walls ideally, and monotony is avoided by the indention at the entry and the set-in walls of the bedroom wing and patio.

At the heart of the interior is an open kitchen—an L within an L. An all-purpose counter serves for food preparation and dining. The plumbing backs up to the utility core to provide efficient hookups and minimize wasteful hot-water runs.

This compact (1072 sq. ft.) house isn't hard to build: You erect your perimeter walls (on below-frost footings), apply insulation board to the interior faces (1″ or 2″, depending on your temperature extremes) with metal Z-strips, then pour your interior concrete slab. The rigid insulation projects about two feet below the slab (see section). Your interior partitions can be steel studs.

If you have no local source for the steel roof joists, you could go with lumber; but ask your yard to order joists that have been chemically treated for flame resistance —and cover them with a two-layer plasterboard ceiling. Choose your furnishings with care, and the only things that'll burn in this house are the fireplace logs.—*Al Lees*





TYPICAL EXTERIOR WALL SECTION

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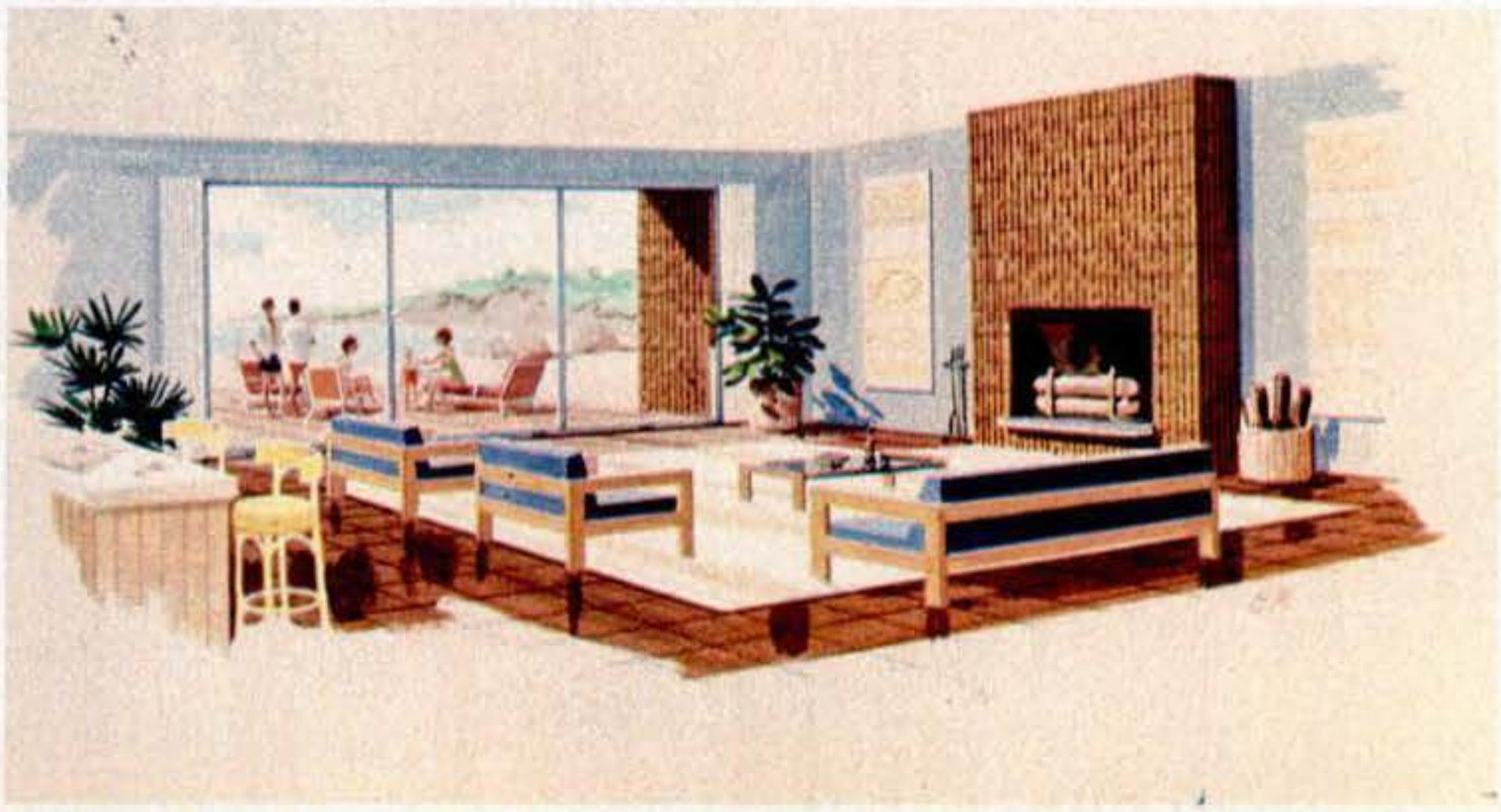

How to order your plans

One set of detailed, professionally drawn blueprints for the Fireproof Retreat is $59; four sets (for building, financing, obtaining permits), $75. Materials list and specifications included at no extra cost. Plans can be reversed, left to right, for $10. Address orders or queries to Homes for Living, Inc. (specify Plan No. 9214), 107-40 Queens Blvd., Forest Hills, N.Y. 11375. Add $3 for handling (all mailing is first class for fastest delivery).

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Kitchen cabinets
–great in any room

Creative thinking turns Kitchen Kompact wall cabinets into a handsome buffet (below). Ceiling-mounted cabinets frame recessed lights to add design interest—and to reclaim waste space.

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For dramatic display, Wood-Mode's ceiling-hung octagonal cabinet (below) has interior lighting. Under-cabinet lights shine through bottle-glass insert. The sculptured-front cabinets of wall, tall, and counter units from Haas (below, left) have a quality look and a durable finish. Smooth plastic bases on Yorktowne cabinets (left) come in a variety of colors; counters are wood grain. Freestanding units create a handy serving bar.

Sturdy, convenient, and handsome kitchen cabinets put unused space to work

By ROBERT GORMAN

Short of storage space in your dining room, den, or workroom? Think kitchen cabinets! In recent years, manufacturers of "kitchen furniture" have broken exciting new ground in decoration and function. While enameled steel, painted wood, and glossy laminates are still popular, much of the new kitchen furniture would not look out of place in any room of your home.

Built for hard use, kitchen cabinets are tough and durable, with handsome finishes that can take all manner of abuse. And many cabinet manufacturers make matching furniture for dining areas, utility rooms, and even bathrooms. Like kitchen cabinets, these units are highly resistant to knocks, spills, and stains.

The versatile units have another advantage. Kitchen renovation often means room expansion—which can create odd-shaped corners and awkward angles. Designed to fill these spaces, kitchen cabinets can solve space problems in other odd-shaped areas—your attic study or basement playroom, for example.

On these pages, we've shown you how well kitchen cabinets can work outside the kitchen. Of course, the new styles can also do great things for your kitchen. Even small kitchens often function as dining or work areas as well. So we've pictured some clever new cabinet designs that enable your

Continued

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kitchen to do double duty—or more.

Where to start

Whether you're remodeling your kitchen or revamping work/play areas, there are some basics you should know about kitchen cabinets.

Spend some time browsing through design centers and dealers' showrooms. You'll get ideas, and maybe learn a few design tricks that you can adapt to your own needs.

You should also assemble a collection of manufacturers' catalogs. Besides showing what's available, the brochures have tips on how to use these space-saving cabinets most effectively—in or out of the kitchen. Most leading manufacturers also publish booklets detailing how to plan and install anything from a single counter to an entire room. Planning guides are also available from trade associations and many retailers, including the major mail-order houses. Finally, a number of specialized dealers in all parts of the country conduct regular "clinics" giving how-to tips for planning and installation.

Planning is the key

Before you go shopping, decide what kinds of cabinets will make best use of the space you have. All three cabinet types—counter, wall, and tall units—come in modular widths, usually in three-inch increments. This lets you assemble them in convenient combinations to fit between or around fixed objects and wall interruptions.

Counter units come in standard depths (24") and standard heights (34½" including recessed toe space). Adding a 1½" top brings them to a standard 36". Counter tops are usually sold separately, so you can get a seamless unit to span several floor cabinets of different widths.

When planning to install cabinets in an L- or U-shaped area, remember that it's practically impossible to make up a good corner simply by butting straight units together. Toeboards won't meet properly, and you'll also end up with wasted dead space in the corner.

To avoid these problems, plan to fill all corners with units especially made for the purpose. Many of these cut corners diagonally and are fitted with rotating shelves that put dead space to use. Right-angle corner units are also available; they're made so doors and drawers can open without

[*Continued on page 172*]

Durable kitchen cabinets from Boise Cascade (below, left) are smart, practical space-savers for family room. Solid-oak Merillat units with Formica laminate (right) create a simple but elegant room divider. Interiors are completely laminated with wood-look vinyl for easy maintenance. Clever, compact storage units from Wood-Mode (below, right) would also be useful in game or work room. Pivoting center shelves have space behind for brooms.

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A distinctive study (top) features Sears' Belmont cabinets, a knock-down line with self-aligning dowel fastenings for easy, true assembly. Many kitchen-cabinet lines feature matching low units for use as desks, sewing centers, or work tables. Desk units from Coppes (left) and Merillat (above) are tough and sturdy, but attractive enough to fit into any room setting.

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Non-electric battery

stores energy from waste heat

By DAVID SCOTT

MANCHESTER, ENGLAND

A water-vapor battery being developed at the University of Salford Industrial Center could trap waste heat from industrial processes—or even from your home freezer—then tap the stored energy, as needed, to do useful work.

Described to me by one Salford scientist as a "civilized power source," the cheap, ultra-safe, and nonpolluting battery uses water vapor as its working medium, along with a thirsty adsorptive compound, lithium bromide. The compound retains water-vapor molecules by surface adhesion (rather than by molecular penetration, as in absorption), and gives them up when heated.

A Salford battery is made up of a reversible pump/motor and two valve-sealed containers. One container is partly filled with water, the other with lithium bromide. The containers are placed in close physical contact for ready heat transfer by means of conduction.

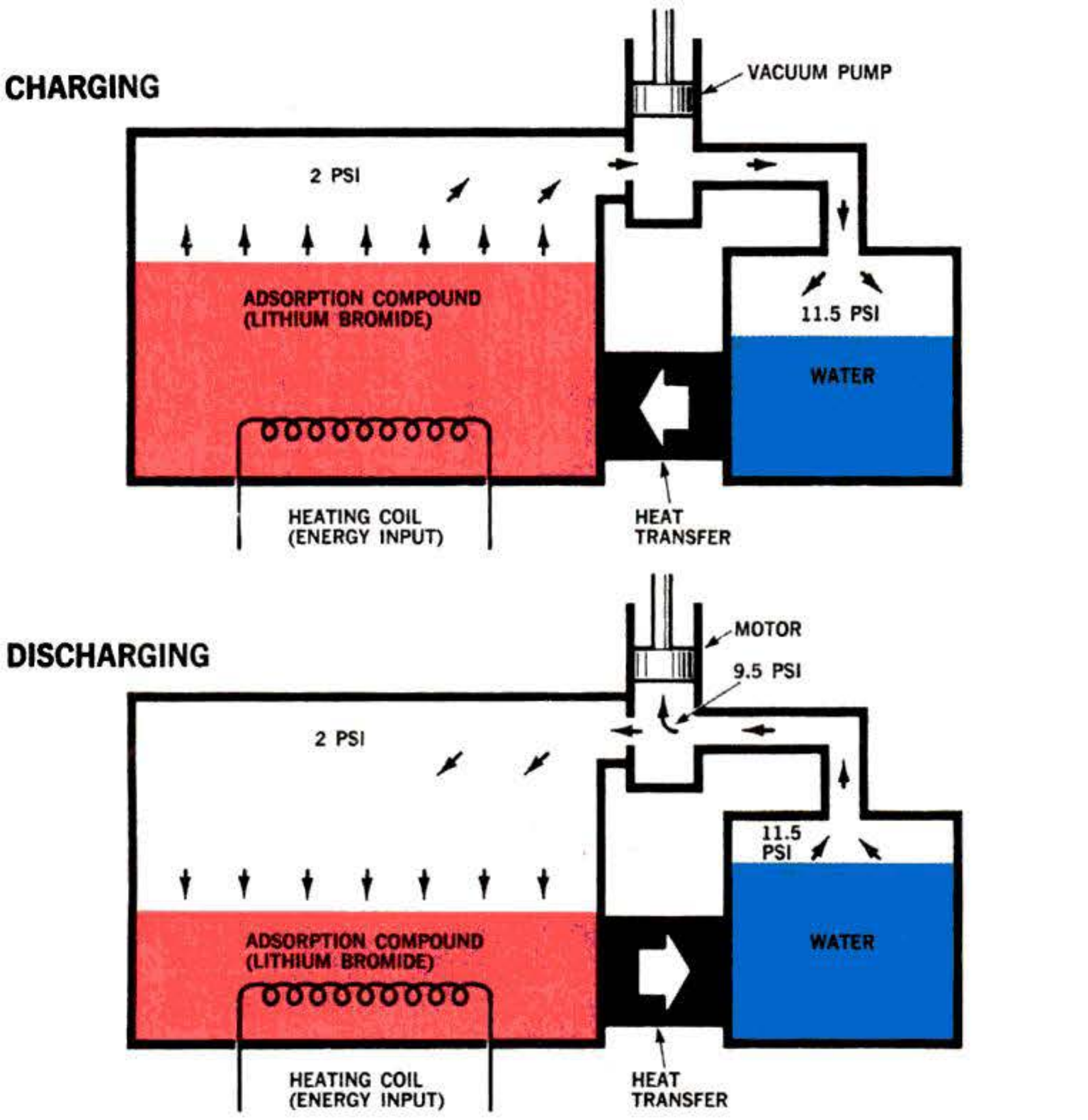
Storage and release of energy result from pressure and temperature differentials. The system is fully charged when water content in the heated lithium bromide (see diagram) drops from its initial 50 percent to about 15 percent. Energy is then stored in the water container as pressurized gas. The battery would be charged up overnight from a heat exchanger coupled to one of the plant's continuous industrial processes.

To tap the battery's energy, you just release the gas; as it expands, it reverses the pump and drives it as a motor. Exhaust vapor is taken back by the compound, and heat given off in the process is conducted back to the water chamber to promote vaporization and maintain the cycle.

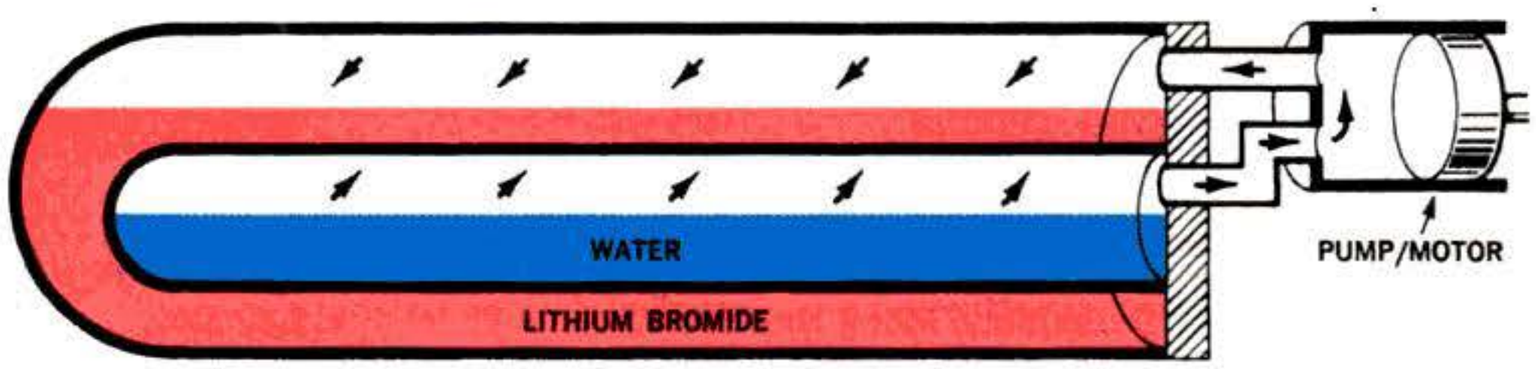
Salford scientists calculate that a modest 9.5-psi pressure differential would be enough to drive an air motor in a safe, spark-free forklift truck, such as might be used in a chemical plant. It could be obtained from a 1000-lb. battery charged overnight at an input temperature of 200° F.

But battery size could be reduced and storage capacity increased by raising input temperatures. At 250° F, for example, vapor pressure differential would rise to about 30 psi.

An experimental three-foot-long glassware assembly I saw at Salford seals the working fluids in two concentric tubes (bottom diagram) that are hose-connected to a reversible pump/motor. Providing maximum two-way heat transfer, the compact, wraparound design foreshadows a range of new battery designs. PS



In charging mode (top), water-saturated lithium bromide is heated (by an immersion coil or by piped-in waste heat). Water vapor released at a pressure of two psi is compressed in the water vessel to 11.5 psi by a low-speed pump. Part of the energy is conducted back to the adsorptive compound as heat; the rest is stored as pressure. In discharge, 9.5-psi pressure differential drives motor; exhaust vapor is adsorbed. (Valves are omitted for clarity.)



New laboratory model seals working fluids in concentric tubes for maximum heat transfer. Tubes are connected to a reversible charging pump/discharge motor.

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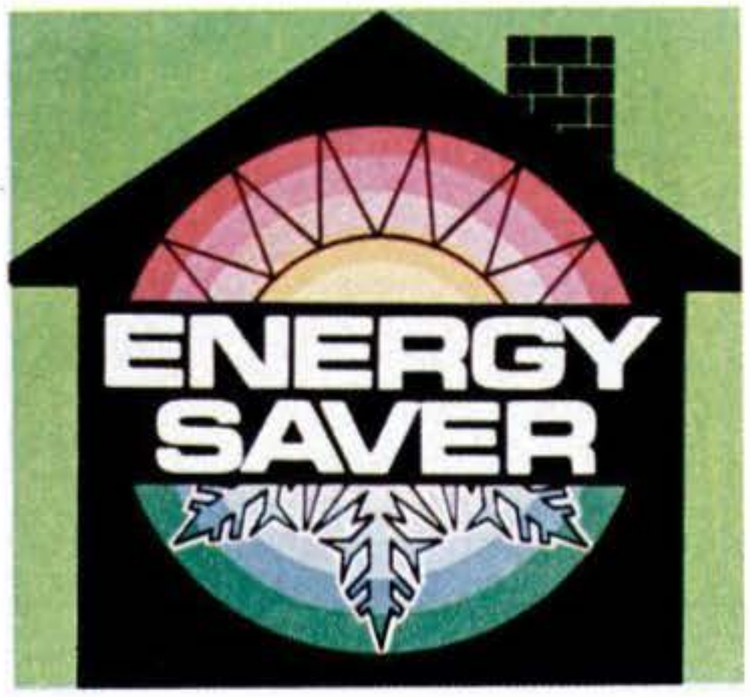
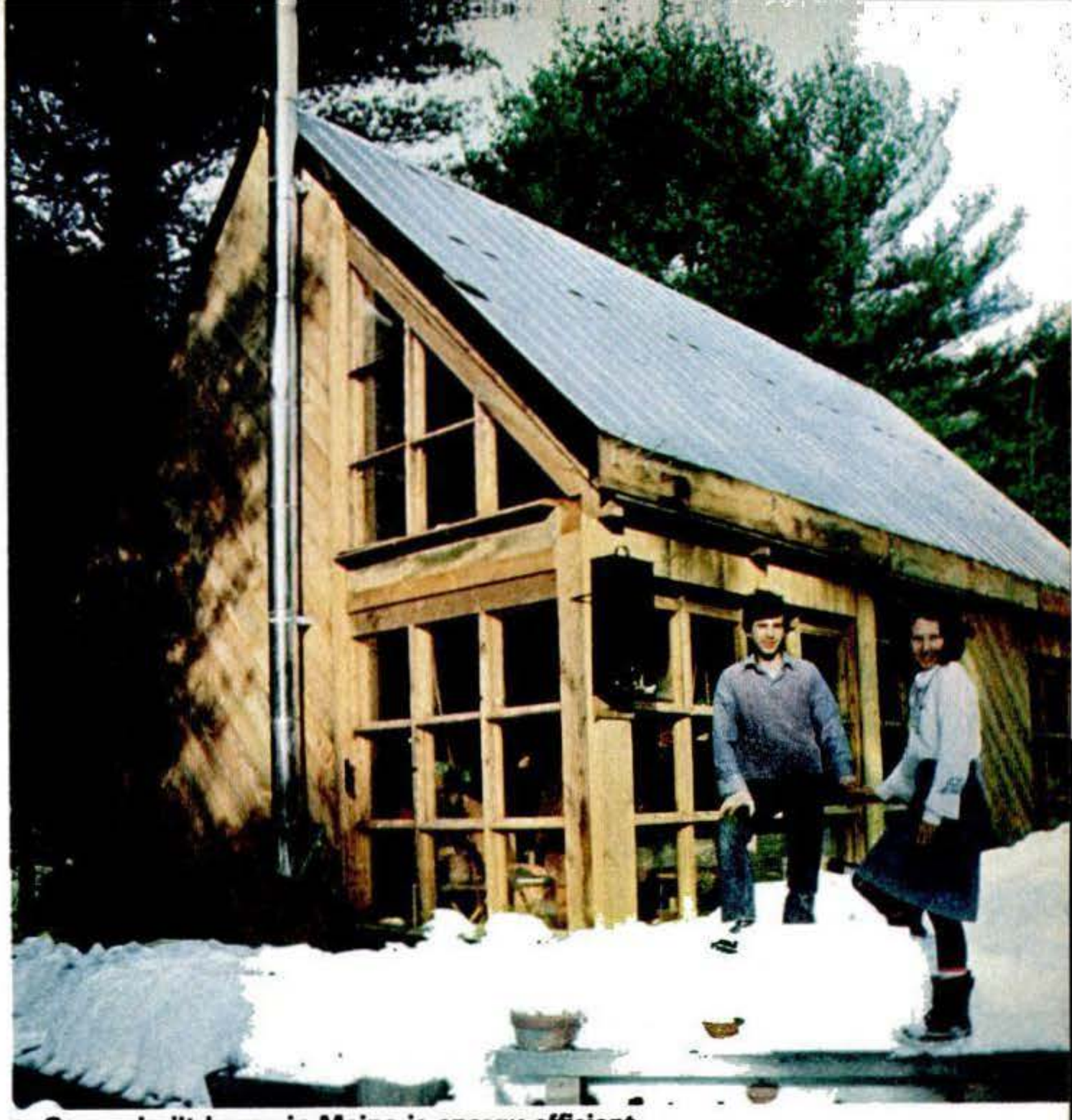


home-improvement ideas



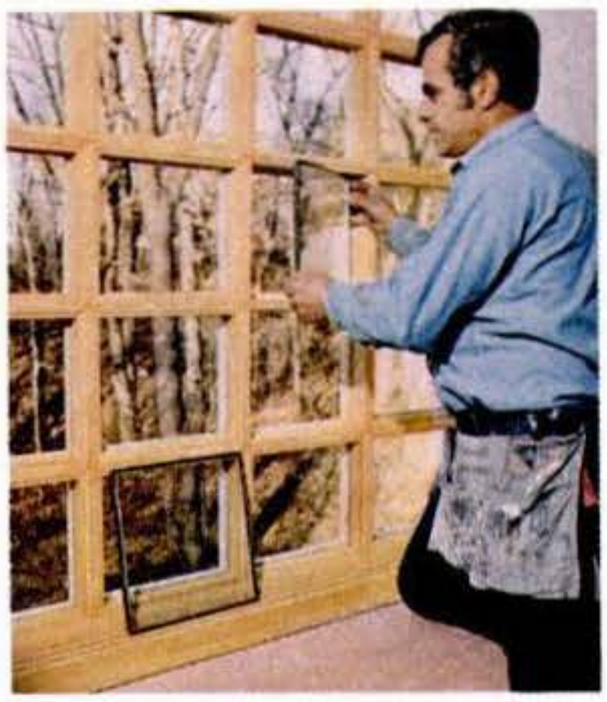
● **Owner-built home in Maine is energy-efficient**

These next pages of our Fall-Winter Home-Improvement section have a special theme: how to buy and use materials that help conserve energy at home. In fact, the first story is on a *school* that teaches prospective DIY builders to create their own energy-saving homes. Then we show how to select the re-siding and glazing materials that'll upgrade thermal performance of existing homes. The important point is that the materials for building energy-efficiency into any home are readily available—and many of them are being flagged with the above symbol at home centers and hardware stores this fall. Other articles in this section (but not sampled in the photos at right) include:

● **Energy-efficient glazing materials**
You now have a wider choice of glazing materials that cut down on heat loss: double- and triple-pane glass, new cellular plastics, solar sheets. You can use them in replacement windows, greenhouses, even flat-plate collectors.

● **Insulation upgrade**
No home improvement pays for itself faster. If you've got adequate insulation overhead, how about underfoot? We alert you to a half-dozen areas in your home where the builder probably skimped, since energy loss wasn't as critical when your house went up.

● **Re-siding can help plug energy leaks**



● **Double-glazing can make picture windows efficient**

● **Stacked barbecue extends outdoor cooking season**

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ENERGY SAVER

Indigenous wood and south-facing glass for passive solar gain typify homes built to Shelter Institute's specs

By ELIOT TOZER
PHOTOS BY TOM JONES

To get to the Hennins' house, I drove out of Bath, Me., on Route 1, crossed the Kennebec River, rattled down a couple of dirt roads, and bounced to a stop in a pine forest. On the far side of the pony corral, beyond the clutter of used cars and pickup trucks, I saw a tidy, rough-finished, single-story dwelling. It had a high, peaked roof. There was a porch all around.

I'd been told that the house would surprise me.

It did.

The front door was four inches thick; it swung open like the door of a bank vault. The south wall was almost all windows—set directly in the wall, with no leaky frames. Everything was made of wood, none of it painted.

The interior had no walls and no ceiling, except for a small library in

"Low-Technology Solar Homes that Work with Nature" [PS, Dec. '76] showed houses that were uniquely adapted to the climate of the Southwest. This article shows how the same concepts—use of indigenous materials, proper siting and orientation of the structure, and passive use of solar energy—can be put to work in the quite different climate of northern Maine.

Post-and-beam house built by Pat and Patsy Hennin (they're shown in front of it in top left photo) is early Shelter Institute design. Two later shed-type homes feature south-facing glass and roof overhangs for summer shading: Perry and Carolyn Hart's one-story home (left), and Doug and Anne Cowie's two-story (above).

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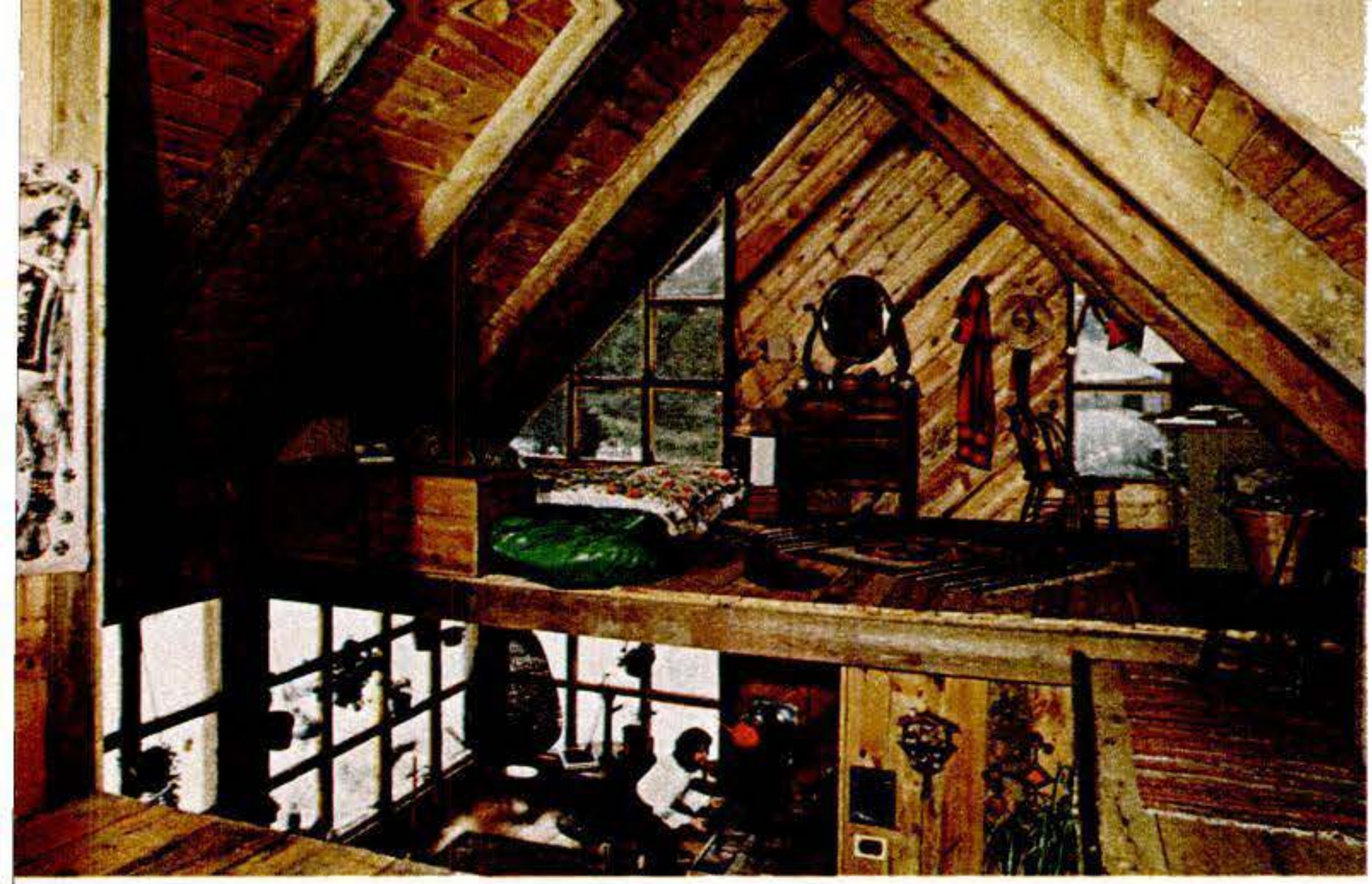
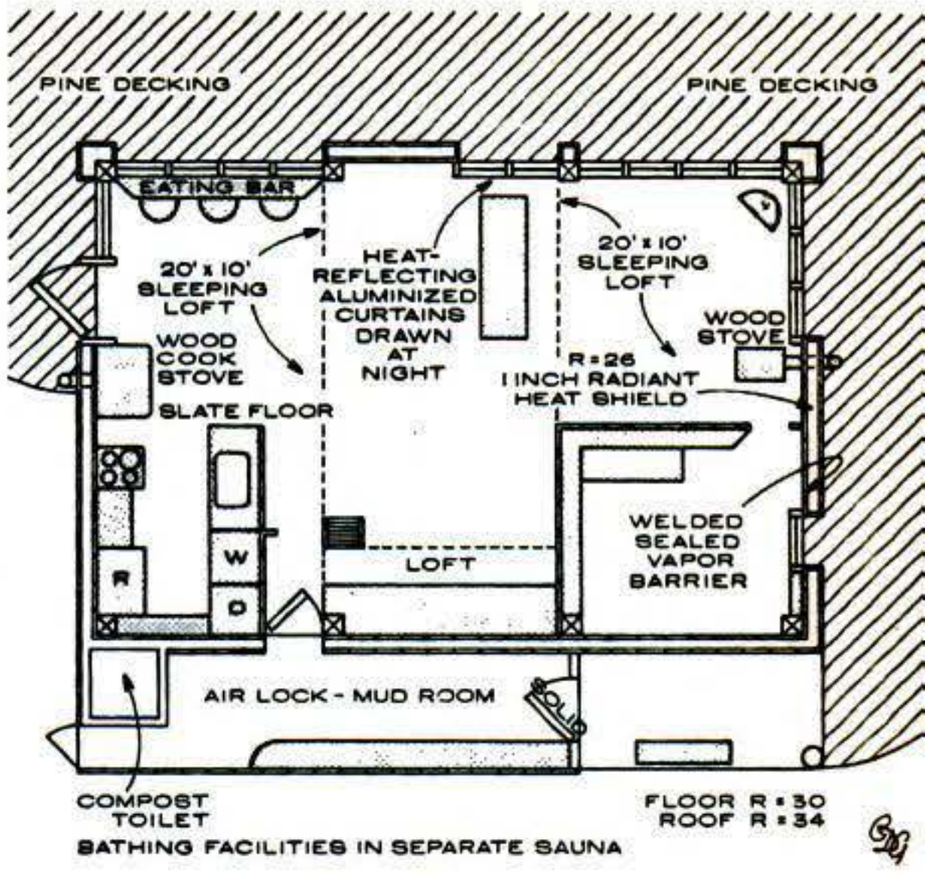




one corner and two sleeping lofts. It was a small house—20 by 30 feet—but it felt big. And it felt right. Solid. Comfortable.

A house comparable in size sells in New England for about $30,000. Pat Hennin, his wife Patsy, and their two boys, age six and eight, built this one for $5000. Complete, and very livable.

Heating costs: zero

But the exciting news in light of today's energy concerns is that the cost of *operation* is so low. The Hennins heat their entire house with one wood stove; last year, it burned 1.5 cords of wood (cost: $0.00). Water comes from a well, courtesy of a hand pump (cost: $0.00). Like the rest of us, however, they pay dearly for electricity.

It's very much the Hennins' house. They got what they wanted because they designed it themselves—from the ground up. And they've taught more than 1100 other people to design their own homes. "I think anybody can design anything he wants to," says Pat.

Pat Hennin is 31. He graduated from Tufts University, with majors in political science and economics, then took a law degree at the University of Maine. Though you might not expect it from his educational background, Pat can fix anything—especially cars and pickups.

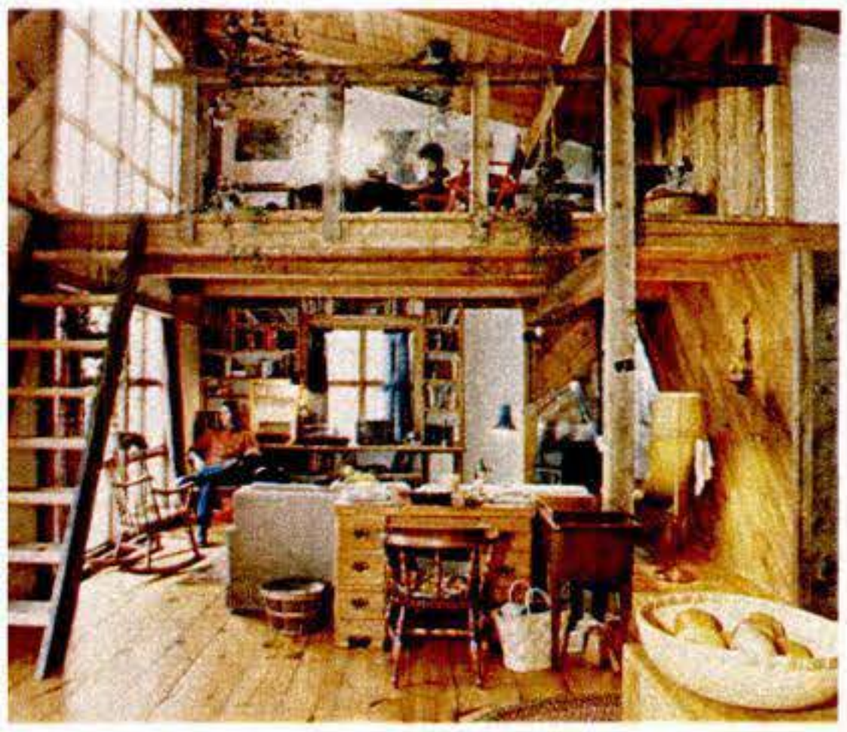
How did he get into the teaching business?

"We're all born with the ability to make decisions," he says. "But we don't use it. We let others tell us when we need a new car and what kind of house to live in. Usually they're wrong."

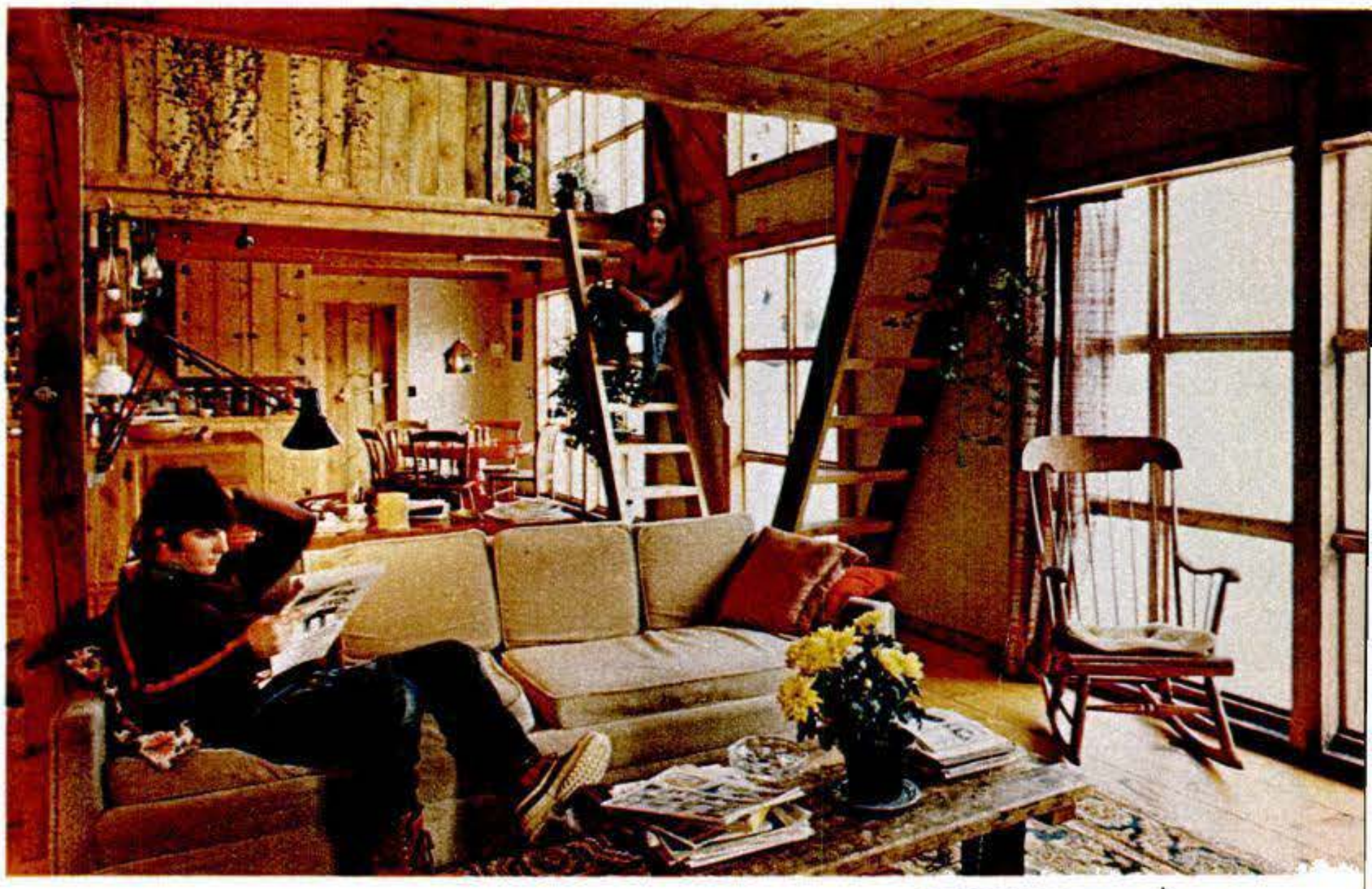
So Pat and Patsy, along with Charlie Wing, a former NASA physicist, established Shelter Institute in 1974. Its purpose is to lead ordinary folk through the maze of decisions involved in designing the "right house."

Continued

Interior of Hennin home is "open plan" (see floor plan above), with sleeping loft (above, left). Roof's uninsulated appearance is deceptive: Four-foot-square boxes made of 2-by-10's *above* the tongue-and-groove sheathing hold 10" fiberglass batts, with aluminum roofing on top. Home's main level (above) features plenty of wood, weathered beams, and wood-burning stove (a Jøtul). Walls have six inches of insulation, and windows are either double- or triple-glazed.



Interior of Cowie house has double sleeping lofts with access ladders located in two-story-high section of main level. Above, you're looking toward living room; corner behind wood-burning stove has galvanized heat-reflector/shield. At right, you're looking in opposite direction toward kitchen/dining area.



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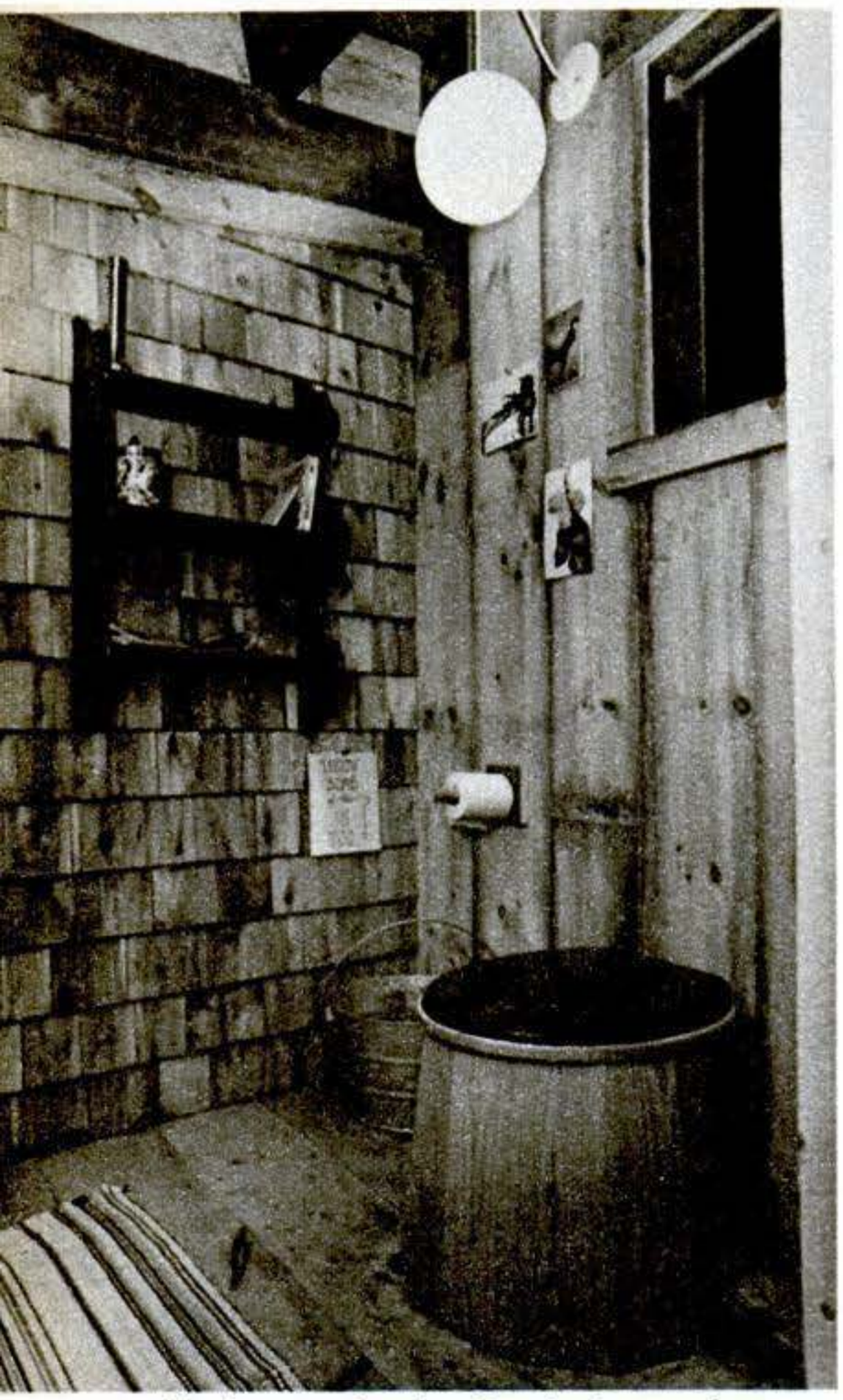
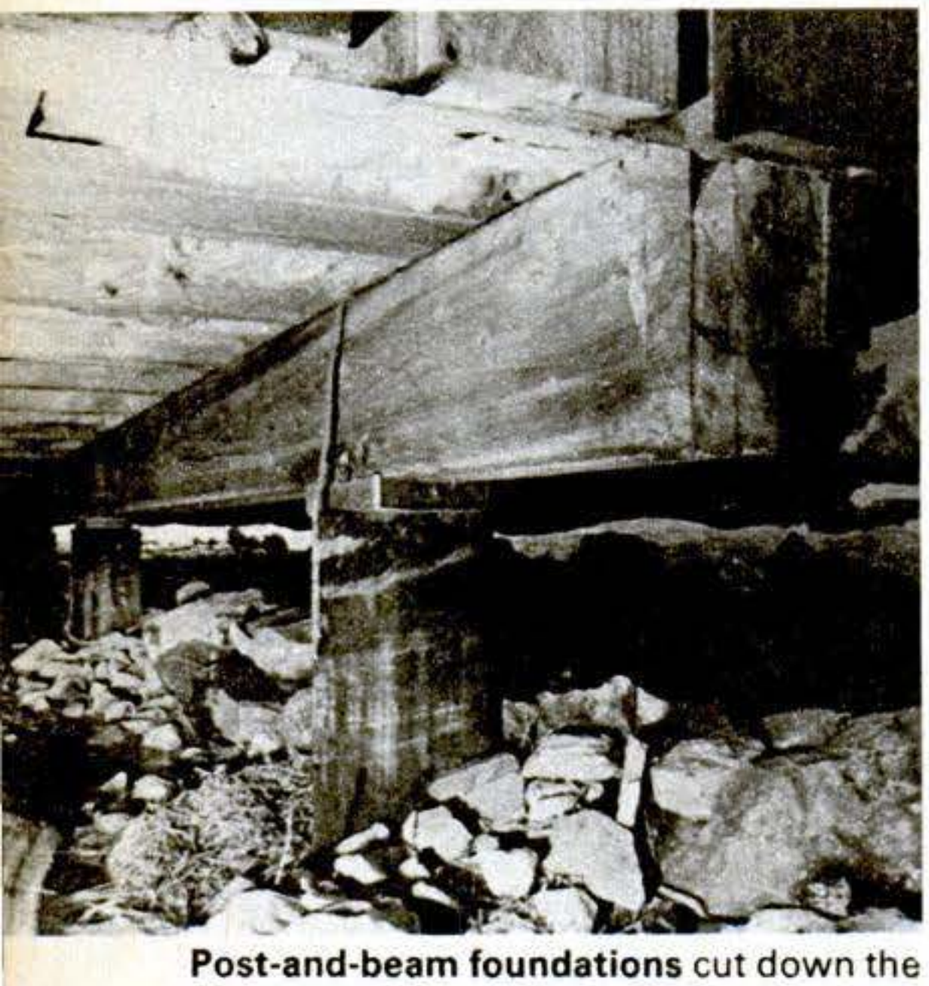
S.I. offers two courses, the basic course of 45 classroom hours in which they teach the philosophy and engineering of house design, and an open-ended design seminar in which students—under the guidance of an instructor—talk each other through actual design and construction. The institute library, which contains books on building, catalogs of materials, and national and local codes, can be used at any time. Instructors visit sites during construction or answer questions by mail. The basic course, which can be taken over a period of 15 weeks or crammed into three weeks, costs $250 per person ($350 per couple). The design seminar costs $100.



Bathroom in the Cowie home features Clivus Multrum, a Swedish-made composting toilet that also accepts organic kitchen waste.



Post-and-beam foundations cut down the high cost of building. Shelter Institute estimates that this foundation costs $400; a full basement would cost $2000.

"We don't offer anything new," says Pat. "A lot of the old saltbox houses around here were built on the principles we discuss—use of solar energy, orientation to the sun or prevailing wind rather than to the street. We teach basic physics and math and encourage our students to use them in a different way."

Functions, options

"For example," he says, "take the foundation of the house. First, you consider its function. It's supposed to support the building, anchor it, and stabilize it during freeze-up and thaw.

"Then you consider your options. There's the full basement, perimeter wall, pilings . . . We discuss 14 different kinds of foundation so each student can use the one that best meets his needs . . . climate, soil, aesthetics, use, cost."

The rest should be simple. You measure the weight-bearing capacity of the soil, determine the frost line, do a little math, and start pounding corner stakes.

Unless you run into tradition and red tape.

"Banks like to write mortgages on ordinary houses," says Pat. "And ordinary houses have full basements so they'll sell. But full basements don't make sense. You can build an adequate foundation out of telephone poles. They'll carry the weight, and they're not affected by frost. And it's much cheaper. Where an ordinary foundation can cost $2000, our students are building on pilings for $400."

What's more, thermographic-scanner studies comparing S.I. homes with ordinary homes showed that concrete emitted as much heat as windows, but that there was no heat loss under correctly insulated homes built on pilings.

For the first few S.I. houses, Pat went to the loan officers and talked them through the logic of the students' decisions. He says, "After each session, they granted the loan. Now it's automatic."

Can anyone design a house?

"Design," says Pat, "means you analyze the problem—look at all the possible ways to solve it, consider the relation of each aspect to known natural phenomena, then use the best solution. It's usually self-evident. There's no judgment involved.

"The physics is no more difficult than middle-level college physics: simple laws that describe the properties and actions of things in the world around us. And it's high-school math. We've graduated people who never took a physics course in their lives, and now they're doing heat-loss calculations in their sleep."

Don't fight the weather

In S.I.'s 45-hour basic course, Pat, or one of the other lecturers, first discusses climate. "We don't fight nature with blowers and air conditioners," says Pat. "We live with it. Within two miles there can be a difference of 40 frost days per year. It's warmer in the middle of a slope than it is at the top or in a valley. Upwind trees can reduce fuel consumption 30 percent. The Bernoulli effect ["Low- or No-Power Attic Cooling," PS, Aug.] can help move the air through your house in summer."

The next two lectures are devoted to forces and moments, the properties of wood, and the mechanics of fastenings. Then come foundation systems, floor systems, openings, and heating. The final lectures are devoted to plumbing, wiring, the psychology of living space, and preparing your blueprints.

It's not easy to talk in generalities about home heating. You measure efficient and comfortable heating against the lifestyle of the occupants, their comfort requirements, heat source, availability of fuel, the site, quality of construction, and so on. After taking the S.I. course, here's how some students solved the heat problem.

Most students orient their houses to the south—if this means aiming the back of the house to the street, so be it—then install most of the windows in the south wall and design the roof overhang so that the highest winter sun reaches all the way through the house and the lowest summer sun intrudes hardly at all. Even in Maine, cursed with 7680 degree days per year, one can design and site a house in such a way as to heat it entirely by solar gain during sunny daylight hours.

No collectors

Shelter Institute is not yet convinced of the worth of solar collectors: They're too expensive, complicated, and inefficient. Rather, it favors the passive solar house, which, as described above, admits maximum winter light (heat). Some students collect

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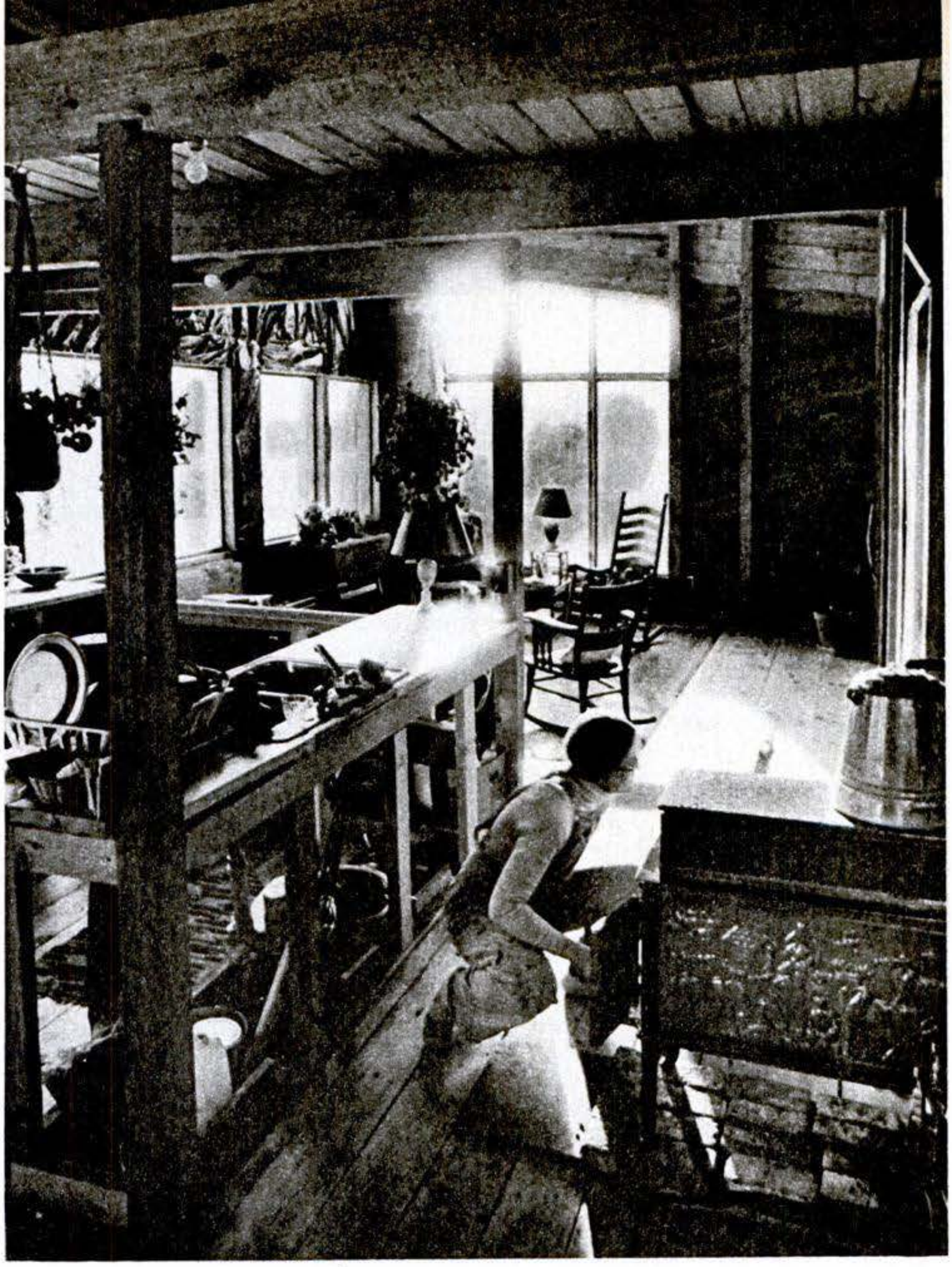

Four-inch-thick insulated door (above) is hand-built—like many other components in Shelter Institute houses. That's Patsy Hennin showing it off.

Pam Kenyon adds fuel to wood-burning stove—a model 118 Jøtul—in her Shelter-Institute-designed home in Dresden, Maine. Bas-relief is standard on this stove.

excess heat in a stone slab or a heat sink composed of water bottles, and draw on stored heat at night.

The passive solar house must be well-insulated: Some have double roofs with two layers of builder's foil between; most have eight inches of insulation in the ceiling and six inches in all walls. Windows are double-glazed; some students cover them at night with Astrolan, a reflecting material they hang as drapes.

Heating with wood

But wood-burning remains the major source of heat. Bob Kalisch, a free-lance writer who designed his own home after taking the course, says, "There's something enjoyable about playing around with a wood fire." Many of the graduates of S.I. would agree.

They're not talking about fireplaces; they're talking about wood-burning stoves, such as the ones you've read about in this magazine [PS, Oct., '76]: small, tight, efficient units that burn slowly, leaving little ash. The Jøtul 118 in Pat Hennin's house has a top efficiency of 76 percent when burning 3.1 lb. of wood per hour. It puts out 22,500 Btu at that consumption rate, and 44,500 when burning 11 lb. per hour.

And one doesn't have to sit right on top of the stove to feel the effects of all this combustion. Students are taught how to make sure all that heat reaches the farthest nooks and crannies. They learn to place the stove so that heat is carried by convection to the far reaches of the house. Judicious use of vents to admit outside air improves the flow. Tests on a house similar in size to the Hennins' showed that air temperature at a uniform height of four feet varied by less than ±5° throughout.

How to save

Skeptics ask: "The design philosophy makes sense, and I think I could learn to design my own, but where do those huge savings come from?"

To begin, graduates save the architect's fee and the builder's profit. That's a big chunk. Then they save by designing the "right house." And, finally, by buying wisely. Pat Hennin points out that one can save 65 percent by buying raw glass by the crate. A standard front door costs $90, but a four-inch-thick insulated clanger can be home-made for $10.

Graduates buy raw steel and cut and bend their own fasteners. They don't use paint or varnish because the house doesn't need them; good design and adequate ventilation banish destructive moisture.

When I asked Pat about the future of the institute, he said, "It will disappear." And he said it with satisfaction. "We're changing attitudes," he says. "After a student has designed a house, he knows he can design anything he needs. And, what's more, he can build anything he designs with his own two hands." He paused. "And they're helping others. Their neighbors, people who never took our course, say, 'I can do that.' And they do." PS

FOR FURTHER INFORMATION

- If you'd like to learn more about Shelter Institute's course on house design, read *From the Ground Up*, by John N. Cole and Charles Wing (Little, Brown & Co., Boston, 1976). It's well illustrated and, as the title implies, it tells you what you need to know to build your own energy-saving passive solar home. The 244-page paperback costs $7.99.
- If you'd like to attend a Shelter Institute course or seminar, write the Institute at 72 Front St., Bath, Me. 04530.

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Re-siding

—for more than a face-lift, choose the right type

By MACK PHILIPS

If your home's wood siding is in bad shape and beyond repair, or if scraping and repainting are becoming a too-frequent problem, you may be considering one of the prefinished re-siding materials now on the market. If you choose wisely, you're in for an energy bonus.

Yes, siding can do more than dress up the place and eliminate a lot of future refinishing. By re-covering your home's exterior you're bound to seal up some leaks, and that can save on heating and cooling costs. In addition, the new siding itself *can* add insulation value to your home (more about that later).

But with the variety of re-siding materials available, how do you know what kind is best for your home? How do you know if prefinished siding will prove cost-effective for you? And is it reasonable to tackle a re-siding job yourself?

First, a look at what's on the market. The re-sides that mimic wood can be divided into two types: "thin" materials (aluminum, steel, and vinyl) and "thick" materials (hardboard, clad particle board, and mineral fiber). The table on a following page shows how they compare in price, size, styles available, and features.

Re-siding materials of all sorts have been improved in various ways in the past few years. Some examples:

- More and more manufacturers of thin re-siding are offering insulation backers that can add meaningful insulation to your walls.
- Improved, longer-lasting finishes have a reduced tendency to fade or chalk—and manufacturers now offer impressive guarantees.
- More textures are available—some mimic wood grain or rough-sawn lumber; some are satin finish.
- New styles have appeared, including some that look like wood shakes. And more vertical siding is on the market.
- Vinyl siding now comes in a somewhat broader range of colors. New formulations are said to be less vulnerable to color changes and much less brittle in cold weather.
- You can buy aluminum and steel siding in rolls. A machine forms the material into full-length pieces right at your house, so there's no need for joints.

Will it pay off?

If your present siding needs frequent repainting, chances are pretty good that covering or replacing it with prefinished low-maintenance re-siding will pay off. The small graph on a following page will help you determine if it will be cost-effective for you.

As a benchmark to compare a prefinished material to unfinished siding, check the price of 100 square feet of materials in the table against these approximate raw-materials costs: 8″-by-½″ cedar lap siding, about $50 per 100 square feet; redwood, the same size, $60; 8″ hardboard siding, primed only, $23 to $45. To these prices, add the cost of painting for a comparison with prefinished re-siding.

Insulation value?

Thick re-siding materials will increase your walls' R-value, as noted in our table. The thin re-sides, by themselves, won't, but they can cut heat loss simply by sealing out drafts. Furthermore, backer boards are now offered for many thin materials. Adding these and/or air space when you re-side can increase insulation value considerably.

Backer materials are typically about 5/16″ to ⅜″ thick. Polystyrene foam that thick has an R-value of about 1.2, polyurethane about R-1.5, and fiberboard, about R-0.9. Any air gap you can pick up is worth about R-0.94 per inch.

Foam-backed aluminum siding plus a layer of reflective aluminum-foil insulation can add up to about R-2.5. Add another layer of foil and a ¾″ air space (with furring strips) and you can get this over R-5.

A new, highly effective backer is available for Reynolds' aluminum siding. The backer is a ½″ thick sheet of polyisocyanurate (similar to polyurethane). Its R-rating is 4. Reynolds claims this material can be put between old and new siding.

Adding the 5/16″ to ⅜″ insulation backer material to the thin re-sides typically increases the price about eight to 10 percent. Using a backer has the added advantage of making thin re-sides quieter, firmer, less likely to "hollow."

Off with the old?

Frequently the thin materials are installed right over existing siding. This saves time and money; it also saves the insulation value of the old siding, plus adding that of any air space between the old and the new. If the new siding extends beyond window and door moldings, you can build out by adding new molding at the outer edge of existing trim.

Thick re-siding materials are most commonly applied to the sheathing after the old siding has been removed.

If the old wood is badly deteriorated or loose, you probably will be far ahead by removing it, even if you're

Simple cottage, right, is spruced up nicely with Colorlok hardboard re-siding from Masonite. Photo above is "before" shot. Masonite booklet tells how to apply over old siding. (Re-siding time is good time to add blow-in or foam insulation.)

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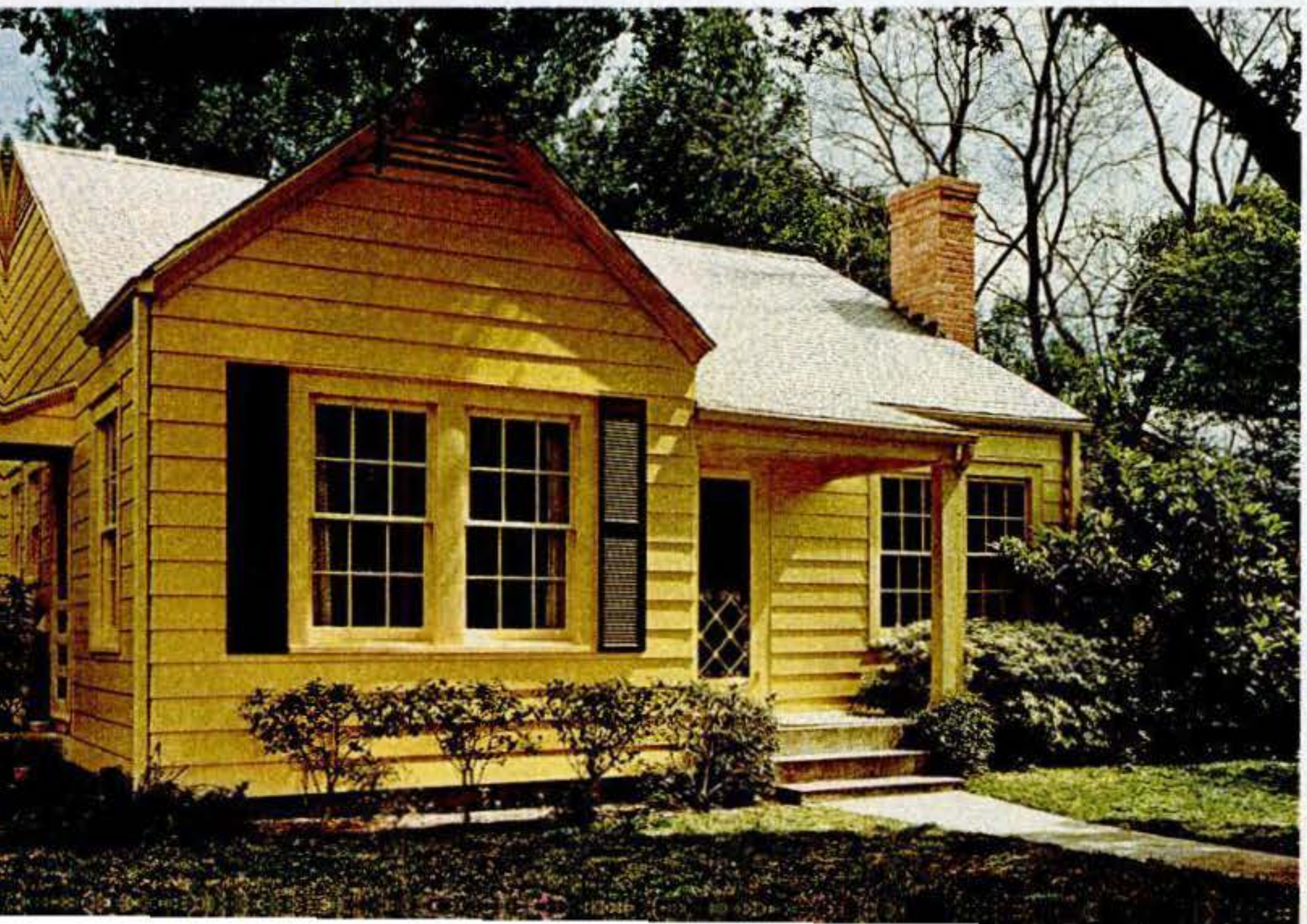

Re-siding with prefinished materials needn't change basic appearance of house. Johns-Manville's new "double 4-inch" vinyl (two four-inch clapboards on eight-inch panels) preserves classic beauty of this Georgian frame house.

using a thin re-side. Because their finish is so perfect—particularly on glossy, non-textured types—any of the thin re-sides may show an accentuated unevenness when installed over old siding that's bowed or warped.

Will retaining old siding cause condensation problems due to moisture trapped behind the impervious new material? It probably won't, under normal circumstances. A vapor barrier on the inside walls gives added insurance against moisture build-up. Most of the thin re-side materials

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have weep holes in the bottom edges to allow the walls to breathe, and even if they don't, there should be enough gaps at the joints to allow venting.

If you live in an older home without insulation in the walls, re-siding offers a special bonus: Whether or not you must discard existing siding, what better time to have foam or fill blown in? Homeowners are wary of this retrofit because of the tedious chore of patching the nozzle holes that an insulation contractor must drill at the top of each stud cavity. If you have this job done just before you re-side, you're way ahead.

Upkeep, repair, and refinishing

The fact that re-siding materials are precisely manufactured, nearly perfectly finished, and intended to stay that way for a long time can cause some special problems. How do you keep the siding looking perfect? Or suppose you get tired of the color you've chosen?

All the re-siding materials discussed here—even vinyl—can be repainted. But you will have a tough time duplicating the quality of the original finish—and to introduce the problems of paint-coat maintenance to a "final" finish like vinyl is downright perverse. So choose a prefinish color you can live with. If the siding dealer recommends eventual repaint, get the specs and file them away. But most likely your only maintenance will be an occasional cleaning. All prefinished siding can be dusted with a soft brush or hosed down and wiped dry.

All types of re-siding can be damaged, so find out how to make repairs when you buy. In general, you can handle a scrape on metal siding much as you would touch up a spot on your car: Feather out the area with fine sandpaper and repaint. Steel siding should first be primed with red oxide primer. Dents can be filled in with an auto-body dent-filling compound. Hardboard, particle board, and mineral-fiber siding can be touched up the way you would repair paint dam-

1 Vinyl siding from Mastic shows typical colors, textures, patterns. Deep colors are still not available in vinyl; they expand excessively in bright sunlight.

2 Steel and aluminum siding come in a wider range of colors than vinyl, including some fairly intense hues. Large, deeply textured panels are Reynolds' "shakes."

3 "Thick" re-siding also comes in wide range of colors, textures. Far left is clad hardboard; next, batten panel and lap hardboard; on right, mineral fiber.

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age on wood siding. Gouges, dents, or holes can be repaired with wood filler or caulking.

With vinyl siding, the color goes all the way through, so a scratch or abrasion won't reveal a base color, as it will with the other materials. If a scuff or scratch looks objection-

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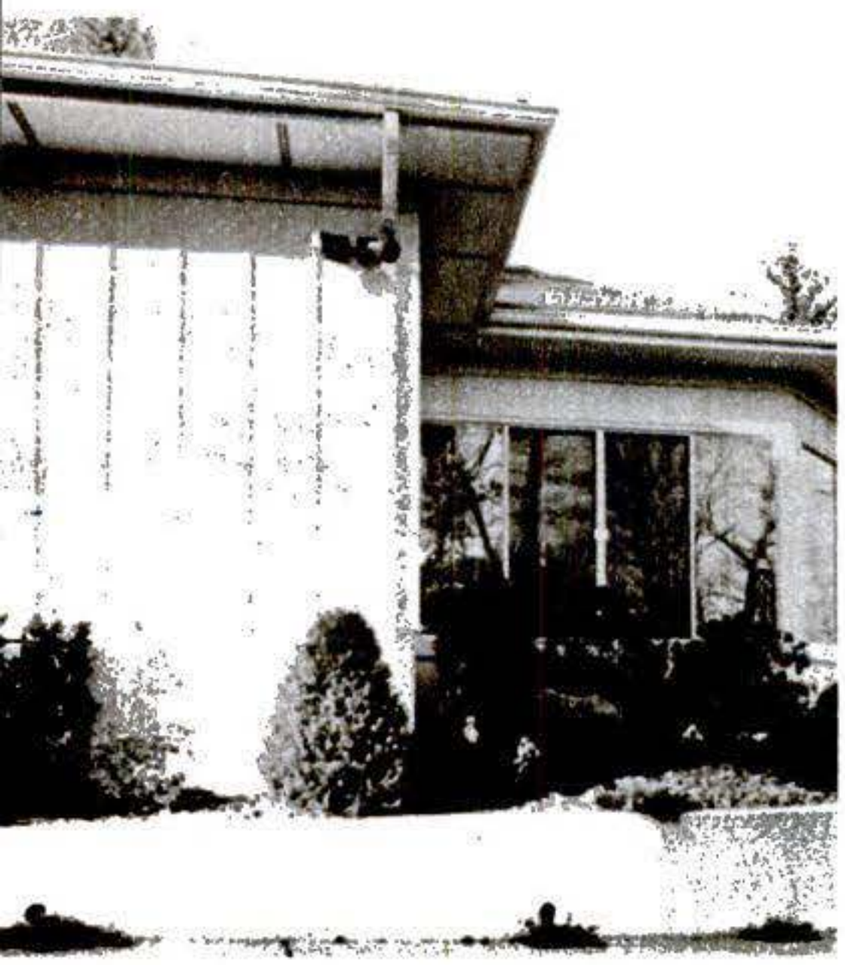
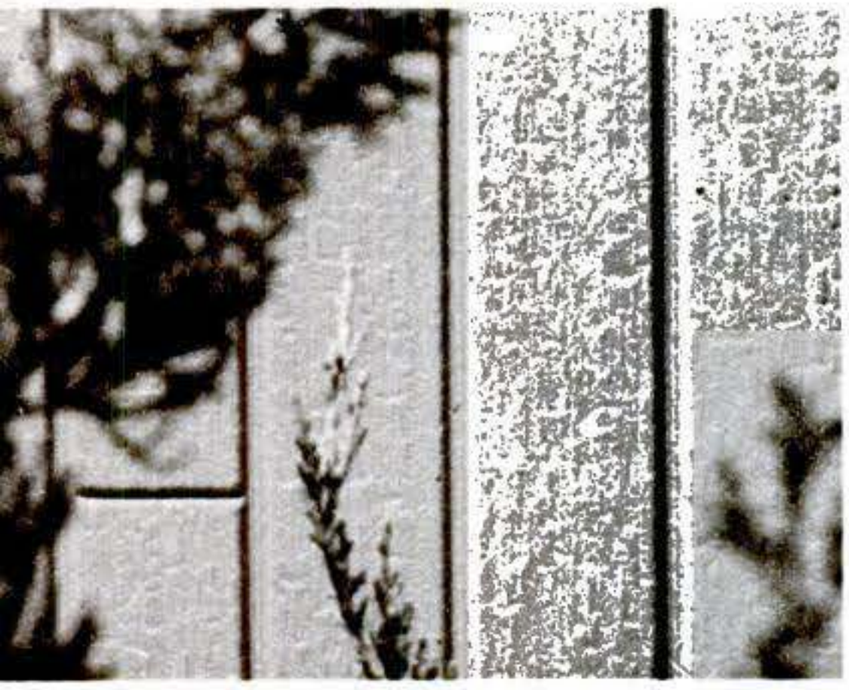


Colorlok panel siding from Masonite Corp. has special hardware for fastening to wall under the batten strips. Vertical siding is available in most materials.

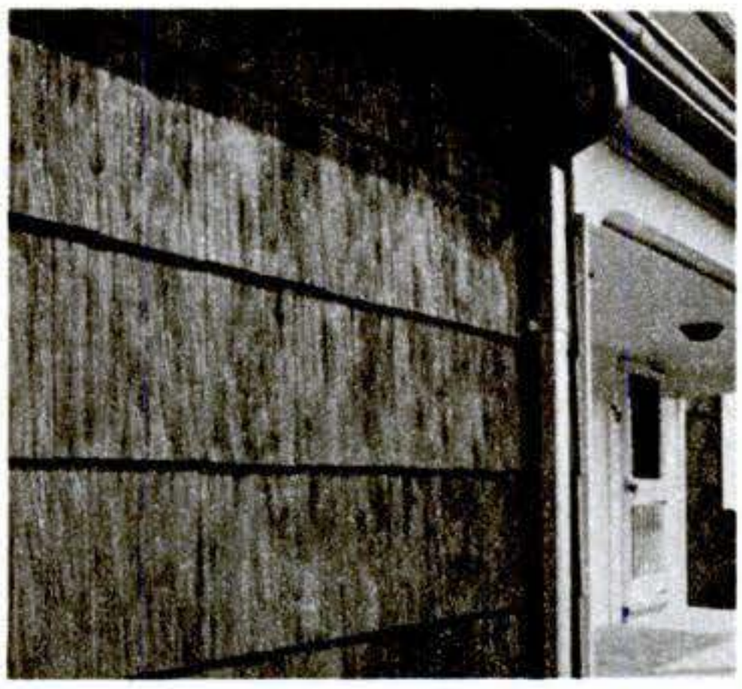
How prefinished low-maintenance re-siding materials compare

	Vinyl	Aluminum	Steel	Hardboard	Clad particle board	Mineral fiber
Description	Formed or extruded solid polyvinylchloride	Formed coated aluminum sheet	Formed coated steel sheet	Coated compressed wood fiber	Wood particleboard with bonded wood fiber overlay, coated	Coated compressed Portland cement and mineral fiber
Approx. cost per 100 sq. ft. (material)*	$60-80	$60-90	$70-90	$35-80	$40	$30-50
Approx. cost per 100 sq. ft. (material/labor)*	$140-200	$140-200	$155-210	$100-125	$80-125	$100-125
Type(s), finish coating	None—color is integral	Vinyl, acrylic	Vinyl, acrylic	Vinyl, polyester	Not specified	Polymer plastic
Textures (in various colors)	Smooth, wood grain, other textures	Smooth, wood grain, shake, and other textures	Wood grain, other textures	Smooth, wood grain, stucco	Smooth, textured, wood grain	Wood grain, shake
Material thickness	0.040"	0.019" or 0.040"	29 gauge (0.0135")	3/8"-7/16"	5/8"	5/16"
Relative weight	Very light	Very light	Light	Heavy	Heavy	Very heavy
Types, sheet sizes available	8" & double 4" clapboard x 12'-7"; 8"x10' verticals	Similar to vinyl or roll-formed on job; 12"x24" & 12"x36" simulated shakes	Similar to vinyl† or roll-formed on job	9-3/8"x16' & 12"x16' clapboard; 4'x8' & 4'x9' panels	4'x8' panels	14-5/8"x24" shakes; 8-3/4"x48" clapboard; 12"x24" clapboard; 13-5/8"x24" thatch; 12-1/16"x48" thatch
Usual warranty	20-30 yr.	20-40 yr.	20-30 yr.	5-15 yr.	5 yr., finish/20 yr., material	20 yr.
Fireproof	Self-extinguishing	Yes	Yes	No	No	Yes
Approx. insulation value	Nominal	Nominal	Nominal	R-.45 (7/16" material)	R-.76	R-.4
Electrically conductive	No	Yes	Yes	No	No	No
Termite-proof	Yes	Yes	Yes	Fairly	Fairly	Yes
Corrosion	No	Possibly	Possibly	No	No	No
Moisture resistance	Excellent	Excellent	Excellent	Quite good	Quite good	Excellent
Relative resistance to denting	Excellent	Fair	Good	Excellent	Excellent	Excellent
Soffit systems available	Yes	Yes	Yes	No	No	No
Trim & accessories available	Yes	Yes	Yes	Yes	Yes	Yes
Repaint if necessary or desired	Not recommended	Yes	Yes	Yes	Yes	Yes
Relative expansion/contraction	High	High	Medium	Low	Low	Low

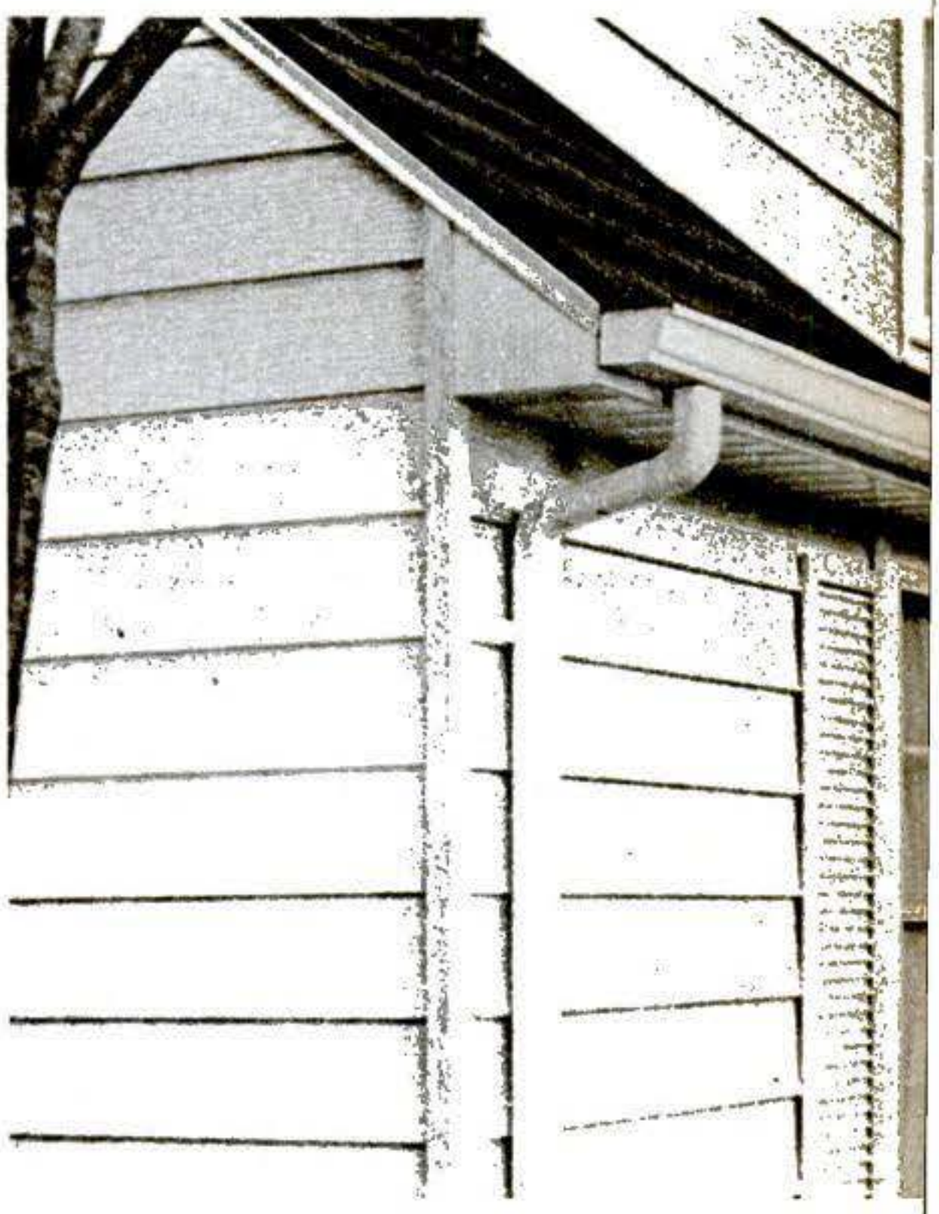
* Prices will vary with shipping costs, local labor costs, job complexity, and trim materials required.
† Steel double clapboard is often double-5" (10" exposure, rather than vinyl's 8").



"Rough-sawn" look, butt-jointed vertical siding is Publishers Forest Products' clad particle board, sold by Rehcon. It's coated with a long-lasting finish.

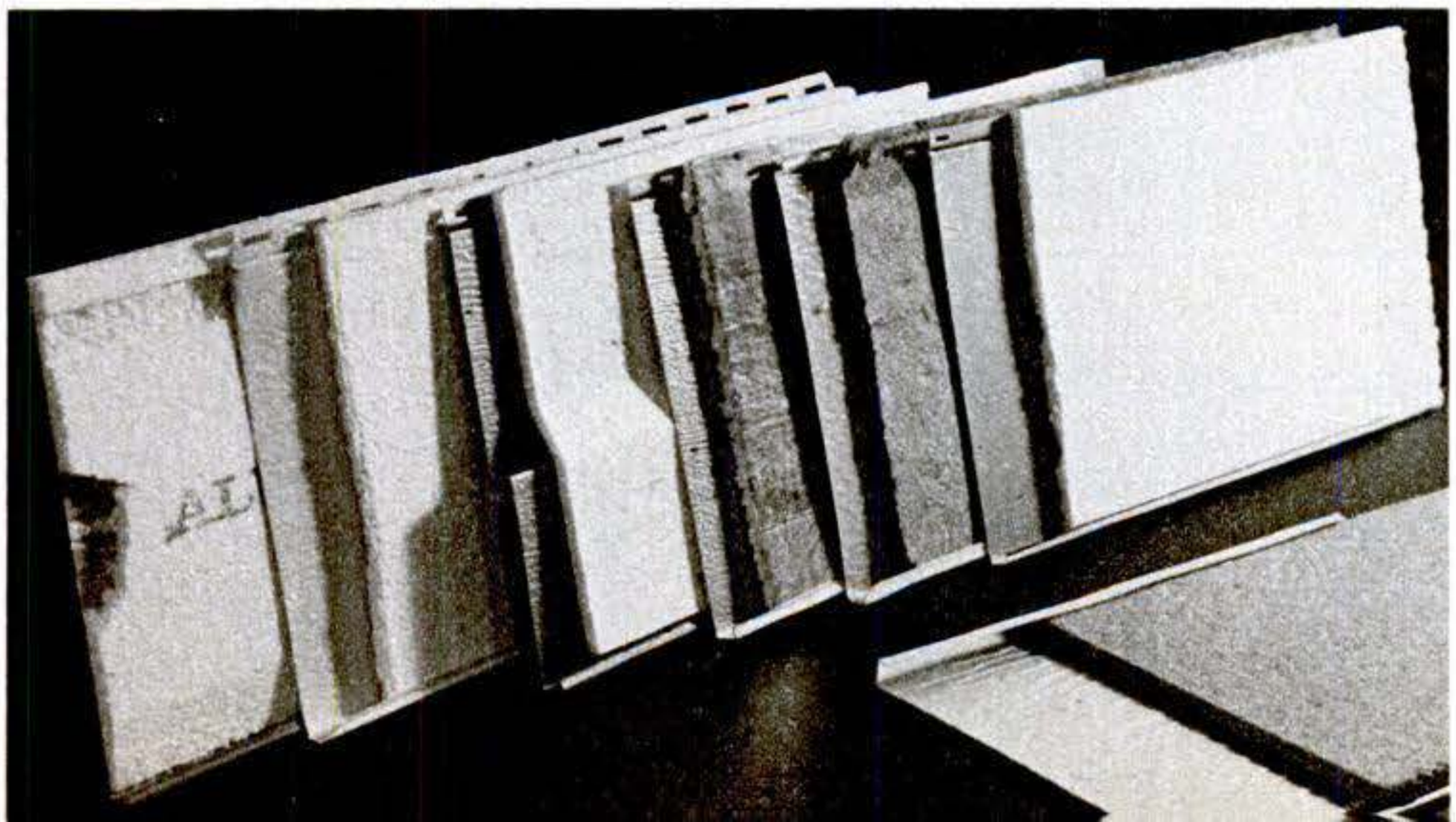


"Thatch" pattern from GAF is mineral siding. It gives beauty and character of wood shingles without expensive care problems. Color range is excellent.



Matching soffit and eave systems are available for many aluminum and vinyl re-side materials. Not replacing such trim pieces? Ask about paint to match new siding.

Insulating backer boards, available for aluminum, steel, vinyl re-siding, can cut heat loss. Many materials are used; some boards are fastened, some are slide-ins.



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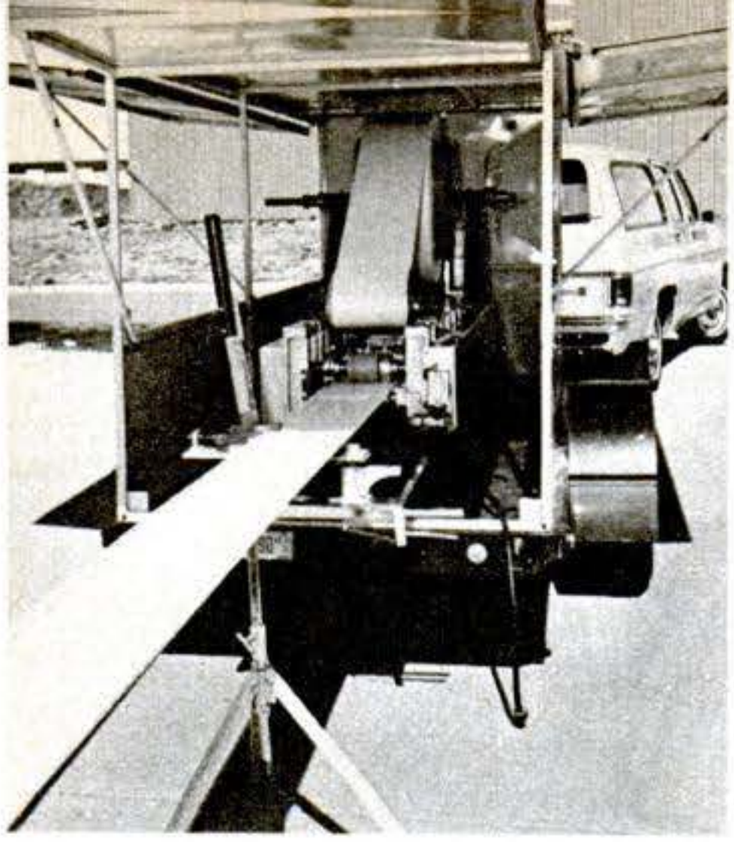
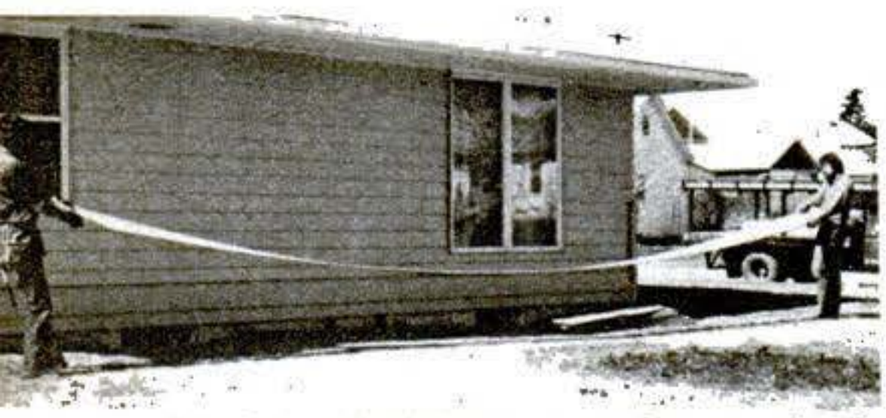
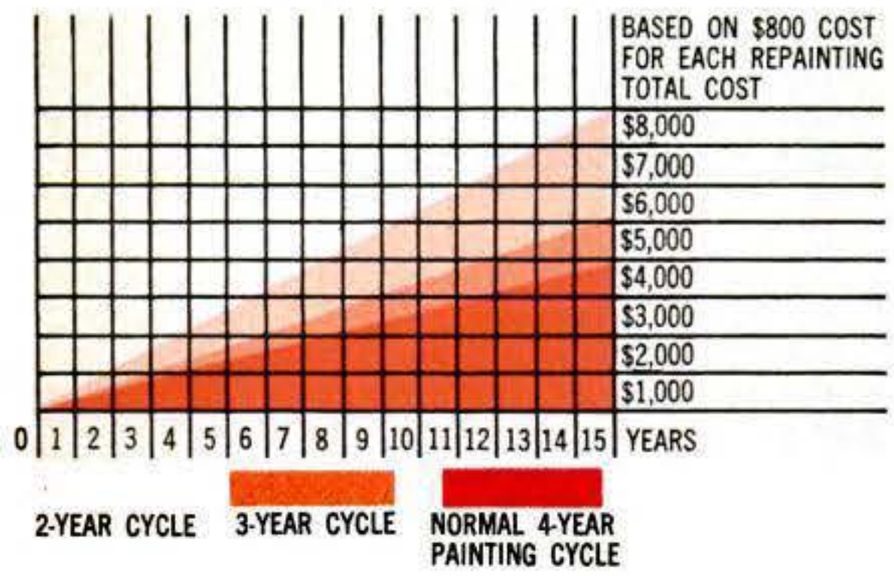




Roll-formed right at your home, aluminum and steel siding can span any length wall without seams. Rolls are available for different patterns and textures.



How much can you save on painting costs? Assuming a paint job costs $800, the graph above gives cost of two-, three-, four-year repainting cycles; lets you compare repainting with new siding.

able, you can probably feather it out by scraping the edges with a sharp knife, or sanding it lightly with fine sandpaper. Since solid-vinyl siding is very resilient, it's not likely to suffer from dents.

When gross damage occurs to any of the materials, you have little choice but to replace the entire panel. So when you buy re-siding, get a few extra panels or pieces. It's protection against the possibility that the manufacturer won't be making the same color and pattern several years hence.

How you remove a bad piece varies. In general, aluminum and steel siding must be removed from the top of the wall down to the bad area because of the interlocking joint system. Vinyl is so flexible you can frequently remove it by the piece, using a special unhooking tool. Depending on the application, you may be able to pry loose a thick panel and insert your replacement piece under the lap.

Compare before choosing

Any re-siding material listed should perform well. Consider both the appearance, illustrated in our photos, and the pros and cons discussed. If you have an old house of which you're proud, you will certainly want to make sure that the "shadow pattern" of the new siding follows the old closely, and that architectural details—trim and molding—can be preserved.

Study the table to see how the various materials compare. To get some idea of the minimum time the

[*Continued on page 170*]

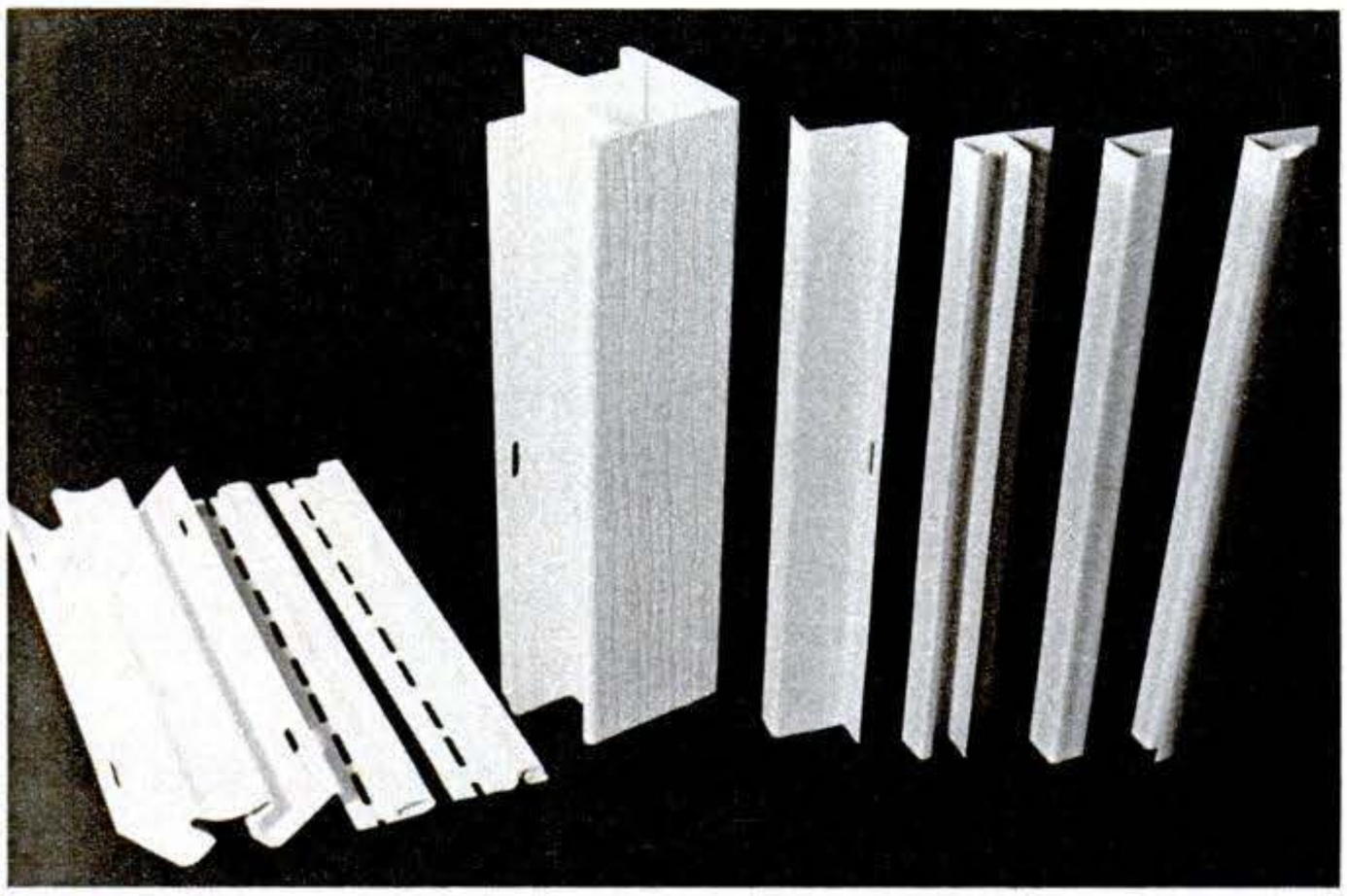
Can you do it yourself?

Most makers of re-siding materials offer excellent, detailed instructions for installing their product. Even the suppliers who roll-form aluminum or steel siding on the job will often bring out a machine and roll you out the lengths you need. You can tell how much money a DIY job will save by comparing costs, with and without labor, using our table.

For hardboard and clad particle board siding, only common woodworking tools are needed. That's pretty much true of mineral fiber, which, however, is extremely hard. You'll need drills for holes and saws that will cut it. To apply vinyl, steel, and aluminum siding, you need standard tools plus a few specialized items that usually can be rented. Be sure to use only the nails recommended.

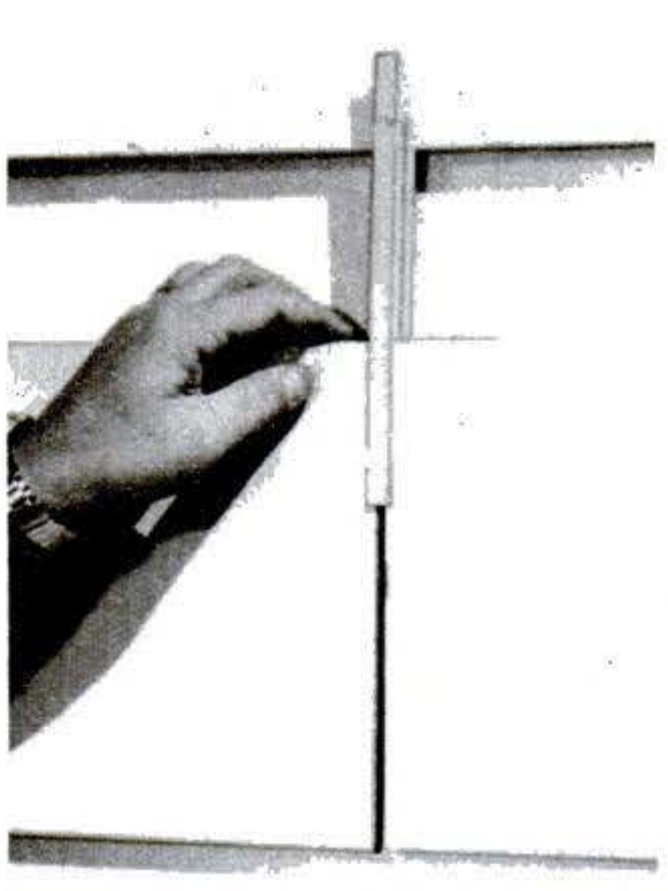
Re-siding a home is a major undertaking, and it will take time. You may need a building permit. Be sure you have safe ladders. Consider renting scaffolding if it will make the job easier and safer.

The key to a successful DIY job is understanding the instructions for the material you use. It's a good idea to get them ahead of time so you can do some studying and planning.



Trim and starter pieces (these are vinyl) make job easier, neater.

Siding installation begins with a starter strip at base of house; first row of panels is hooked to it. Fasten panel at top to accept next piece.



Even hardboard, a "thick" re-siding, can go over existing siding in some applications. Special clip holds joints, makes job look neat.

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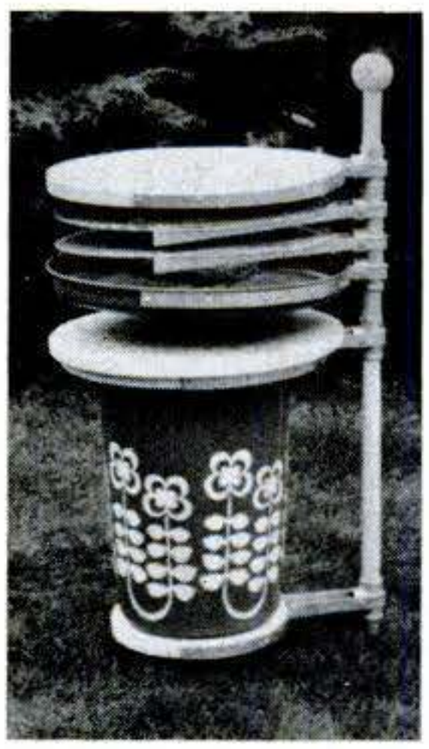
ENERGY SAVER

Build a cook-out pole



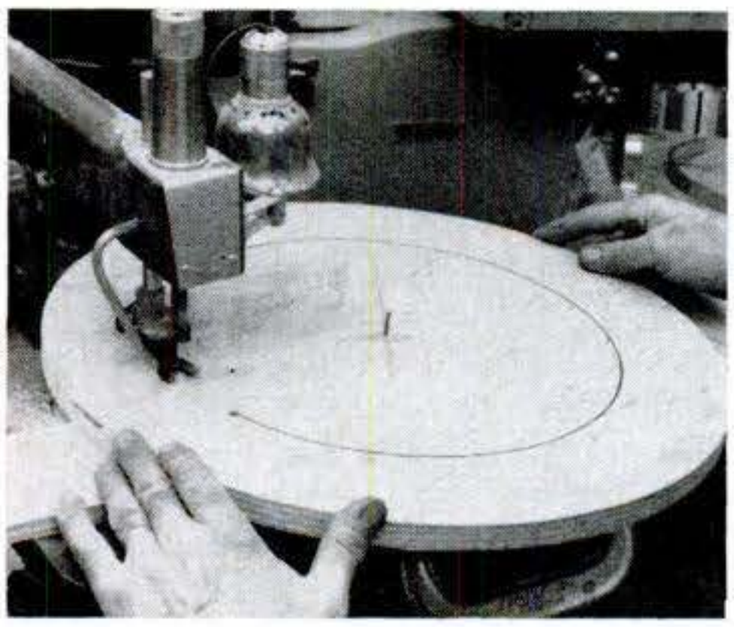
Stackable sections of cook-out pole—cutting boards, charcoal pan, storage basket, and grills—store compactly and swing out to create lots of work space around the barbecue. The galvanized pipe is securely anchored in a buried concrete footing.

Compact barbecue center has storage space, boards for food preparation, and grills for fast or slow cooking

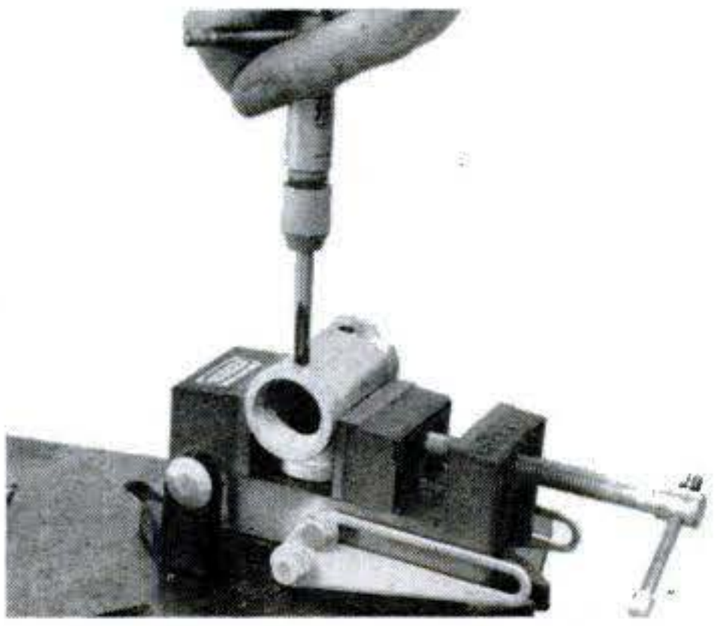
By RO CAPOTOSTO

As a backyard chef, you'll be a real swinger once you install this clever stacked barbecue. And since it's self-storing, it lets you keep all your supplies at-the-ready instead of having to lug them out of a garage or yard shed each time. This convenience can make a real difference in extending your outdoor cooking season, and that will make a small but significant contribution toward trimming family fuel consumption. Better to burn charcoal than gas or electricity while the mild weather lasts.

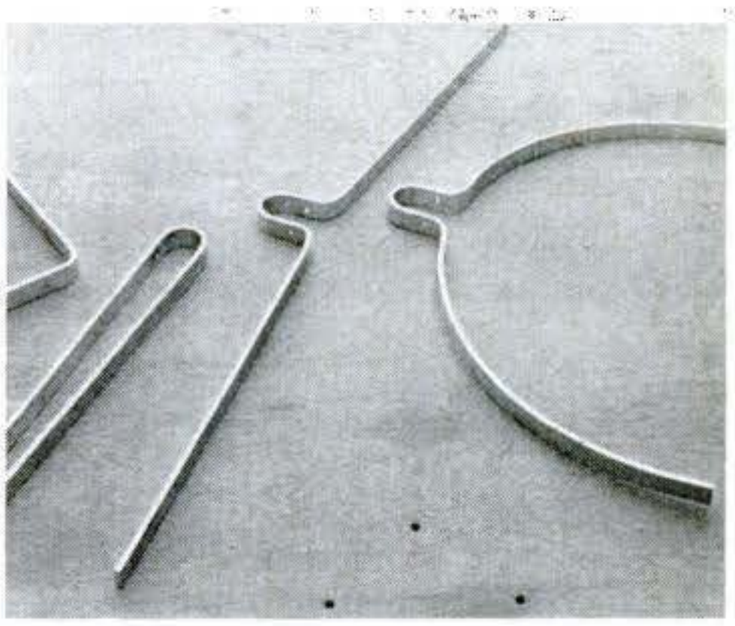
Continued



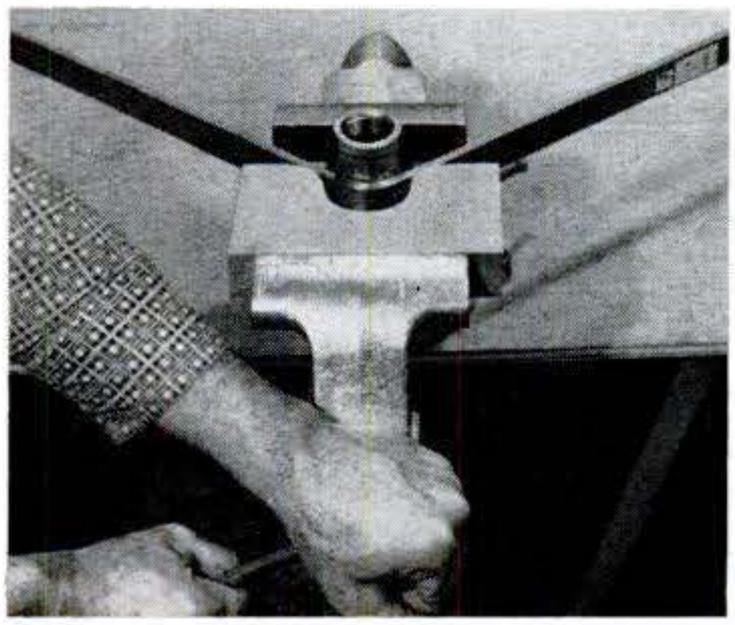
Pivot jig lets you saw perfect circles. Pivot nail is positioned directly opposite the blade teeth at radius distance.



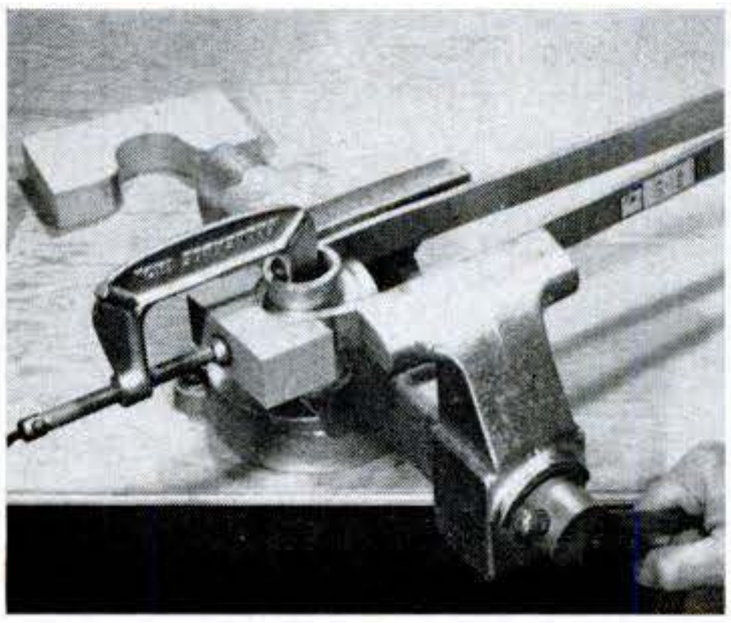
Drill and tap two holes in each T fitting to receive 5/16" setscrews, which take up the play on smaller post.



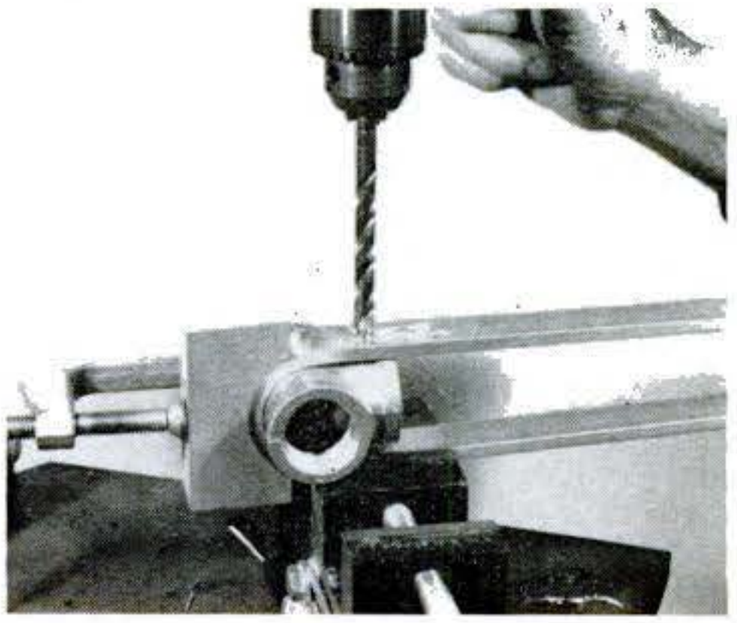
Aluminum bar brackets are formed in four stages, using simple jigs in plans (turn page). All bar is ¼" thick.



Sandwich bar brackets between the block jig and 1" T-pipe fitting and press bar into a right-angle bend.



Clamp smaller block jig over the bend to form a U. Bend the bracket by hand first so it will fit into the vise.



Drill bolt hole through bar and pipe fitting while they are still clamped together and before further bending.

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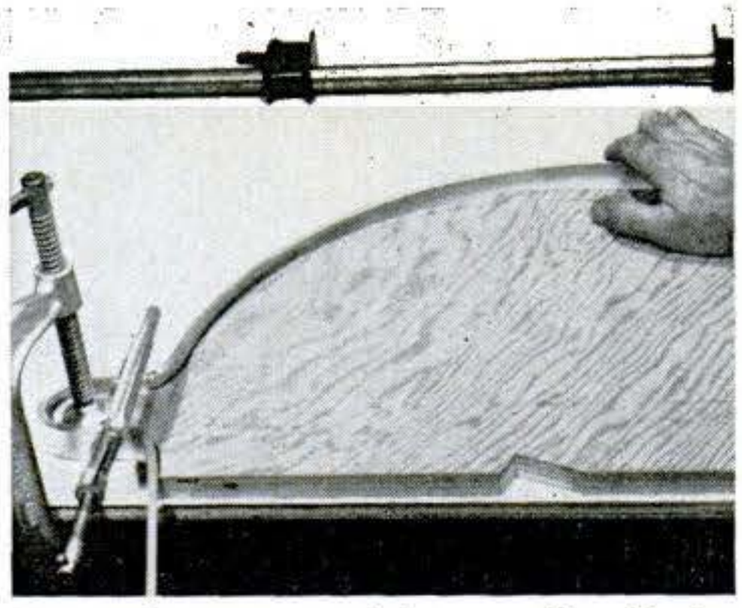
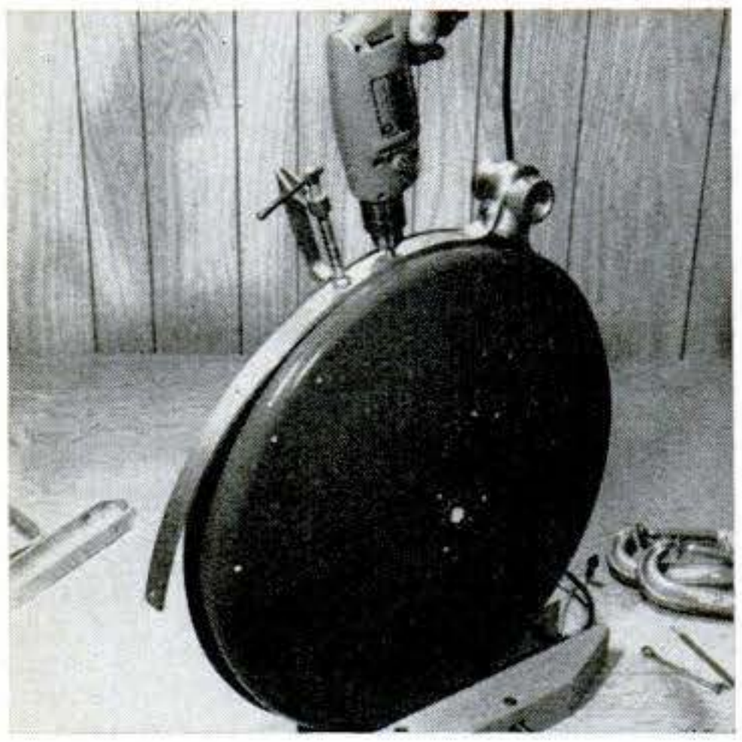
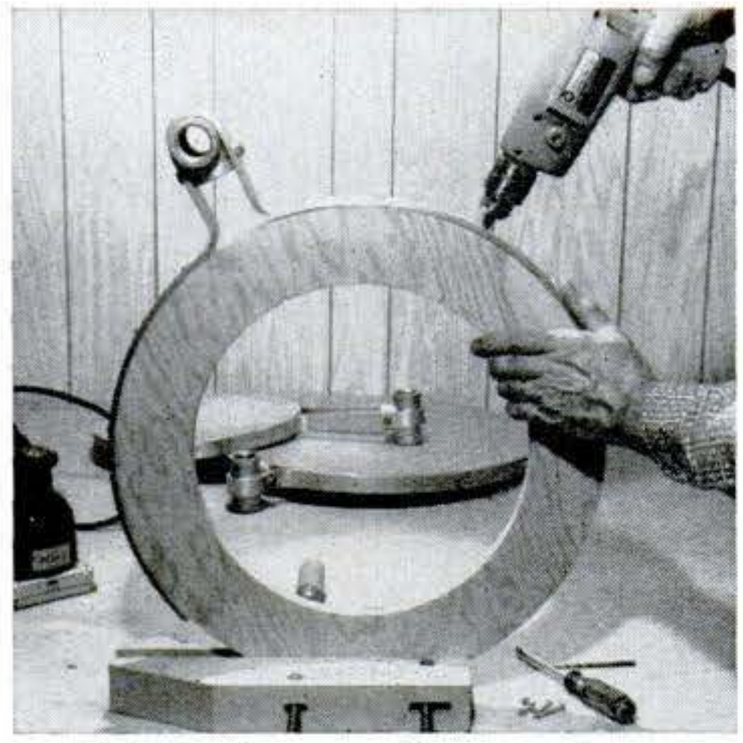
Bend back legs of U by hand. For this step, align the flat of the fitting with the tops of the vise jaws before bending.



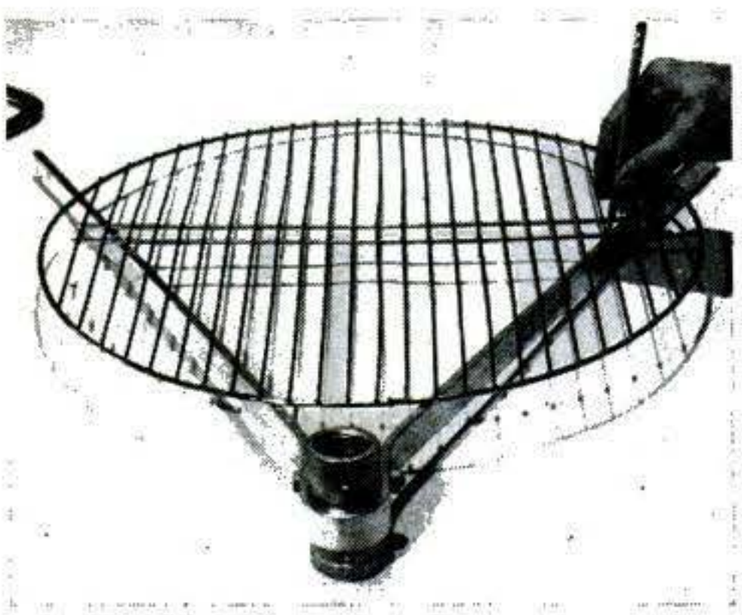
Curve bars around large-radius jig by hand. Use C clamps to hold jig on table, and the bar to the neck of the jig.



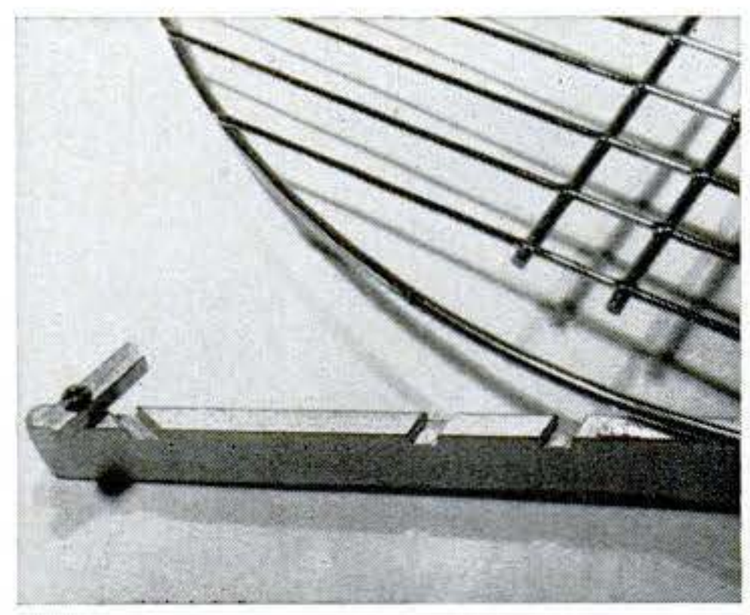
Bolt bar through fitting before drilling connecting-screw holes. Keep advancing the clamp for each hole.



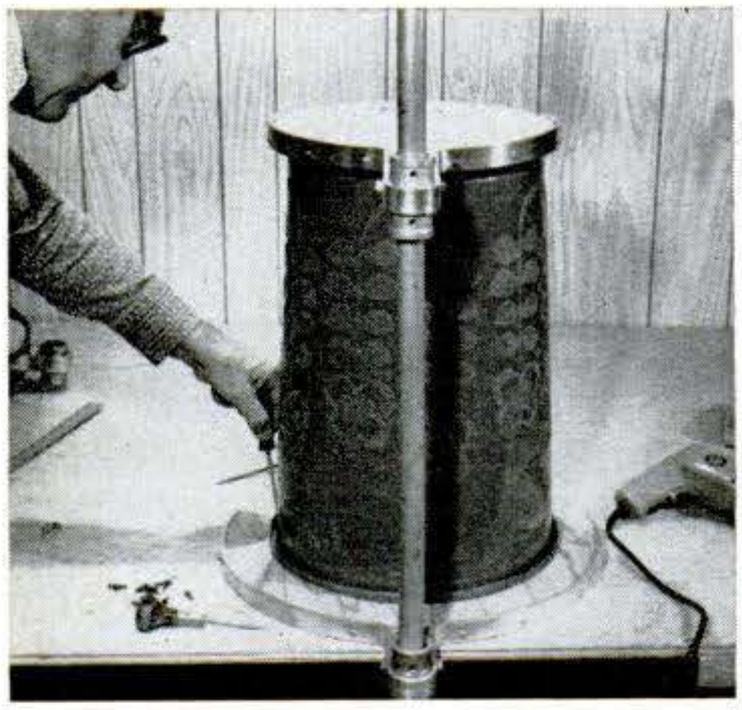
Drill holes for attaching wood components with two drill bits: one for the screw-root diameter, one for the body.



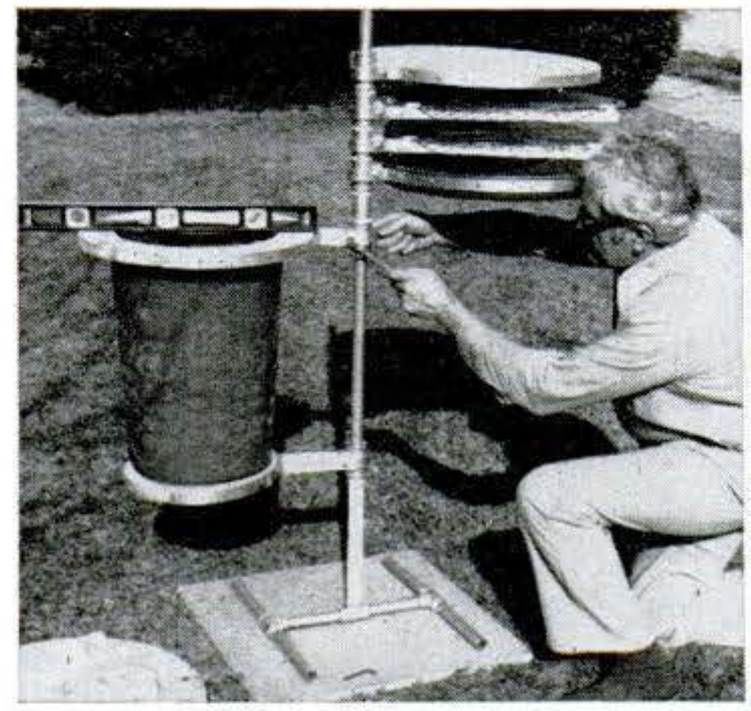
Lay the grill onto the bracket to mark it accurately for cutting notches. Fitting bolt must be attached at this point.



Cut notches into the grill-securing block with a hacksaw and remove waste metal with the edge of a file.



Attach basket to supports with screws. Insert the pipe through the fittings to ensure accurate vertical alignment.



Author shows preliminary test with a level (actually performed after the post is positioned in the ground).

The unit features a charcoal storage bin with a lid that doubles as a work surface and cutting board; the charcoal pan; two grills for high and low heat; and an upper cutting board/service tray. All parts are stacked vertically so you can easily swing any of them about when you go into action.

The cantilevered sections pivot on a length of ¾″ pipe used with 1″ T-pipe fittings and wraparound brackets of ¼″-by-1″ aluminum bar stock. The oversize fittings have about 3/16″ play between them, but two setscrews on each T take up enough slack to minimize wobble.

The barbecue pan and plastic basket shown are available in department stores. Don't proceed until you have these items, however, since you'll have to alter dimensions for substitutes. To avoid rust, use only galvanized pipe and fittings and stainless or galvanized screws and bolts. Aluminum bar stock is available in both 6′ and 8′ lengths. Purchase three 8′ lengths and cut them in half to obtain the six pieces required; six-footers will waste a lot.

Construction

Start by sawing out the plywood disks for the cutting boards and basket supports. For a perfectly circular jigsaw cut, clamp a board across the table with a nail that projects a radius length from the blade. This pivot-point nail must be positioned in a line directly opposite the teeth, not ahead or behind. Otherwise, the cut will spiral.

Drill a small pilot hole in the bottom of the workpiece and also drill a blade-entry hole on the line of cut. When making the basket-support ring, cut the outer circle first to preserve the pivot point for the second cut. The center dropout is not discarded, but serves as the lower basket support.

Next, drill and tap two 17/64″ holes in the backs of the 1″ T fittings to receive the 5/16″ setscrews. Note in the drawing that two fittings have ½″ cut off at one end, and one fitting (for the lower grill) has ½″ removed at both ends. Make these cuts with a hacksaw and grind the ends smooth. These reductions bring the grills closer to the coals.

The aluminum brackets are easily formed in four stages (the grill-support brackets are done in three) with three simple jigs. Work with full 48″ lengths and cut off the waste *after* forming to take advantage of the extra leverage from the longer pieces. First bend the bar to

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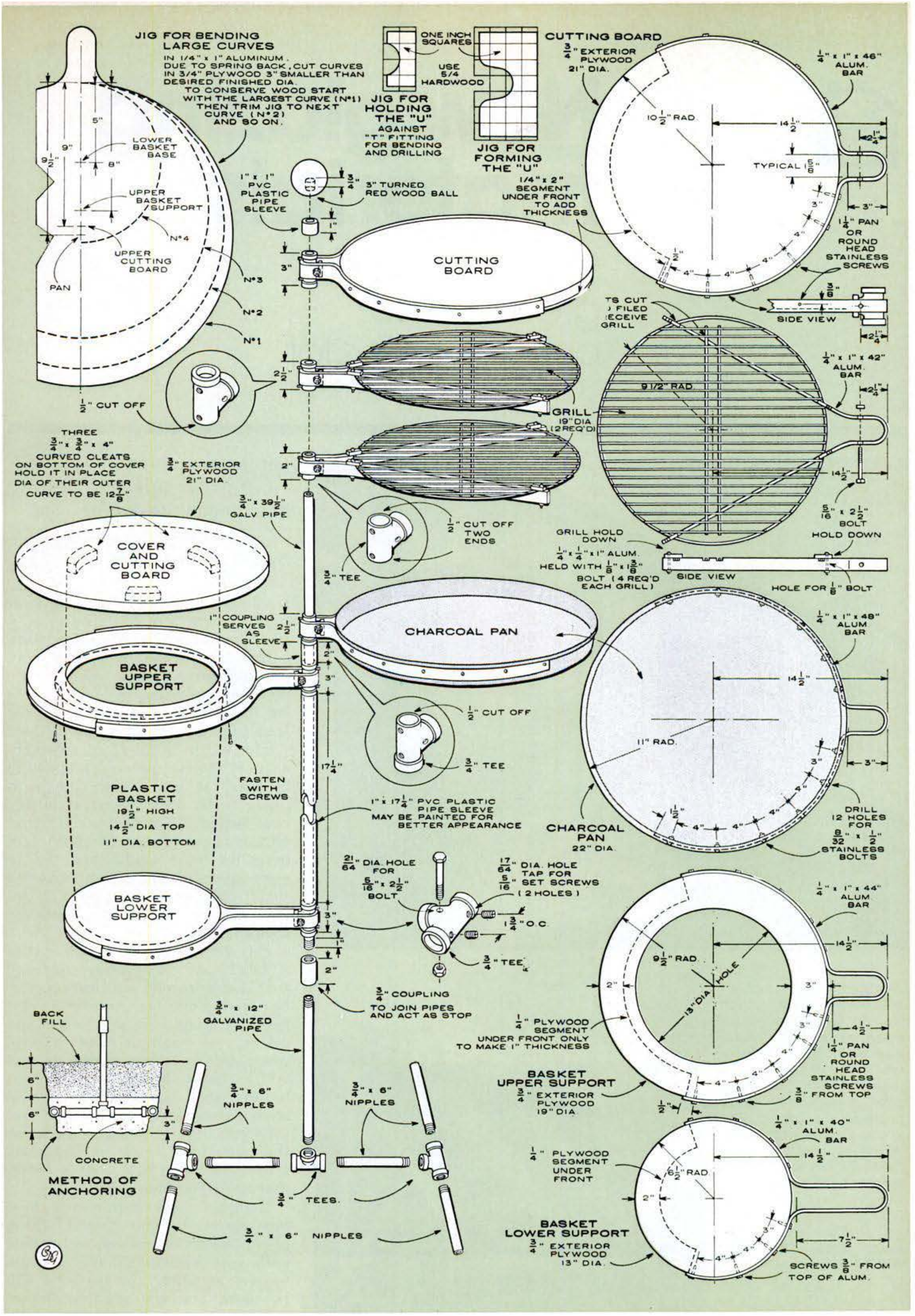

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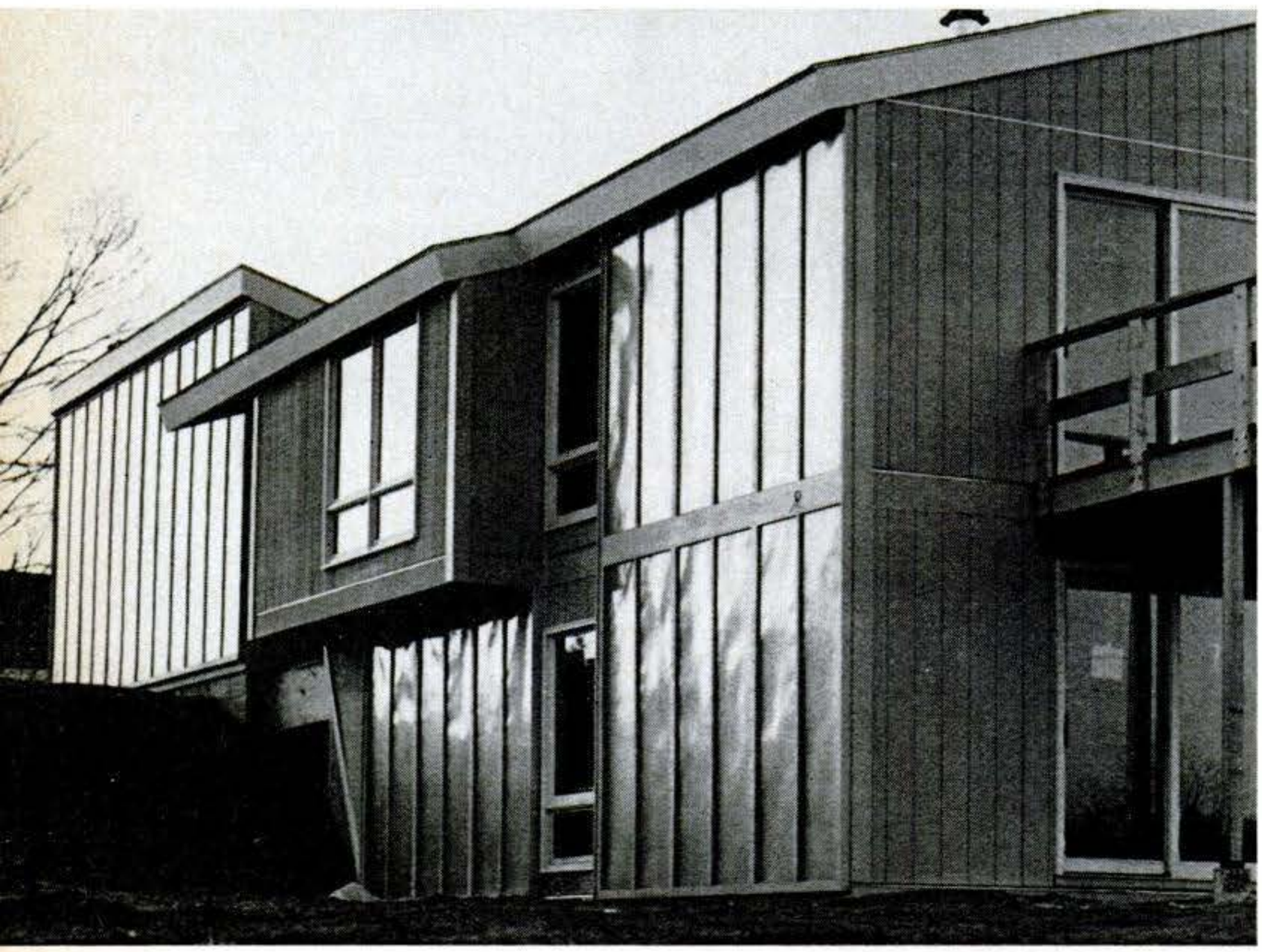
New glazing materials

for your home, greenhouse, or solar collector



Let the sun shine in —but make sure the heat doesn't leak out

By GREG STONE

If you're thinking of replacing your south windows, or building or buying a solar collector, solar wall, hobby greenhouse, or even a modest cold frame, there's one common problem you've got to solve: how to let the sun in while keeping the heat from getting back out.

That's the catch-22 of solar energy. Whatever material is going to be good at letting sunlight in is likely to be pretty good at letting heat escape. To meet this challenge, engineers are turning to what might be called solar sandwiches, two or more layers of transparent covering materials, sometimes with light-transmitting insulation between them.

But the whole field is still sort of a black art. A glazing material that shines in one application may be a dud in another. Acrylic is great from the standpoint of strength and safety, for example, but it sags when temperatures hover around 300°F, which is the kind of heat buildup that can be anticipated in some solar collectors that accidentally run dry. Triple-pane glass, on the other hand, may be cost-effective in Buffalo, N.Y., but a costly luxury in Baltimore, Md.

Before you invest in one of these new materials, you have to think about the problems you can expect with your anticipated use, the environment where the material will be used, and the relative impor-

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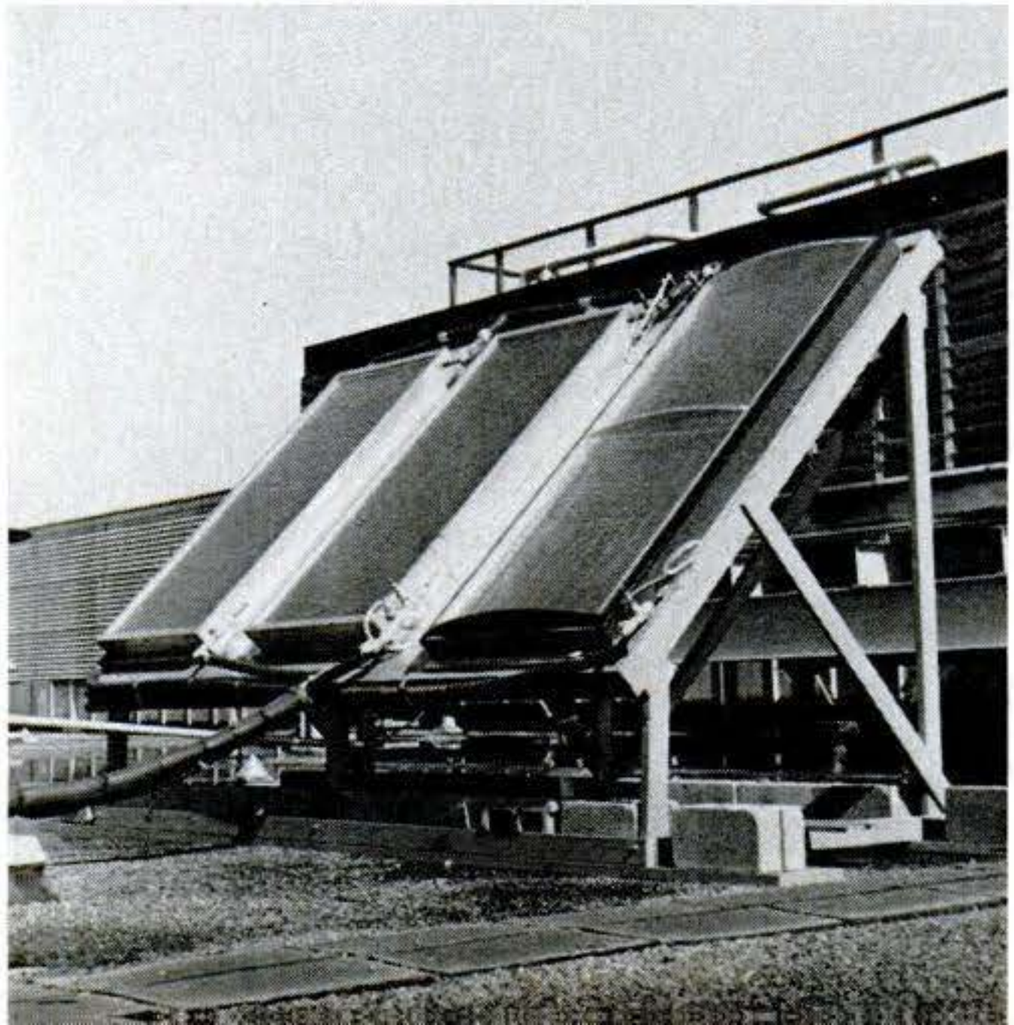

Sunlite fiberglass panels are used on the south wall of this home as a solar-heat collector. Advantage: Fiberglass won't shatter. Disadvantage: Due to UV degradation, it will have to be changed in about 20 years. Comparison tests of three panels (photo, right) showed eight to 30 percent more heat collection by Du Pont Teflon film with Lucite (right) and Teflon with tempered glass (left) than with all-glass panel (center).

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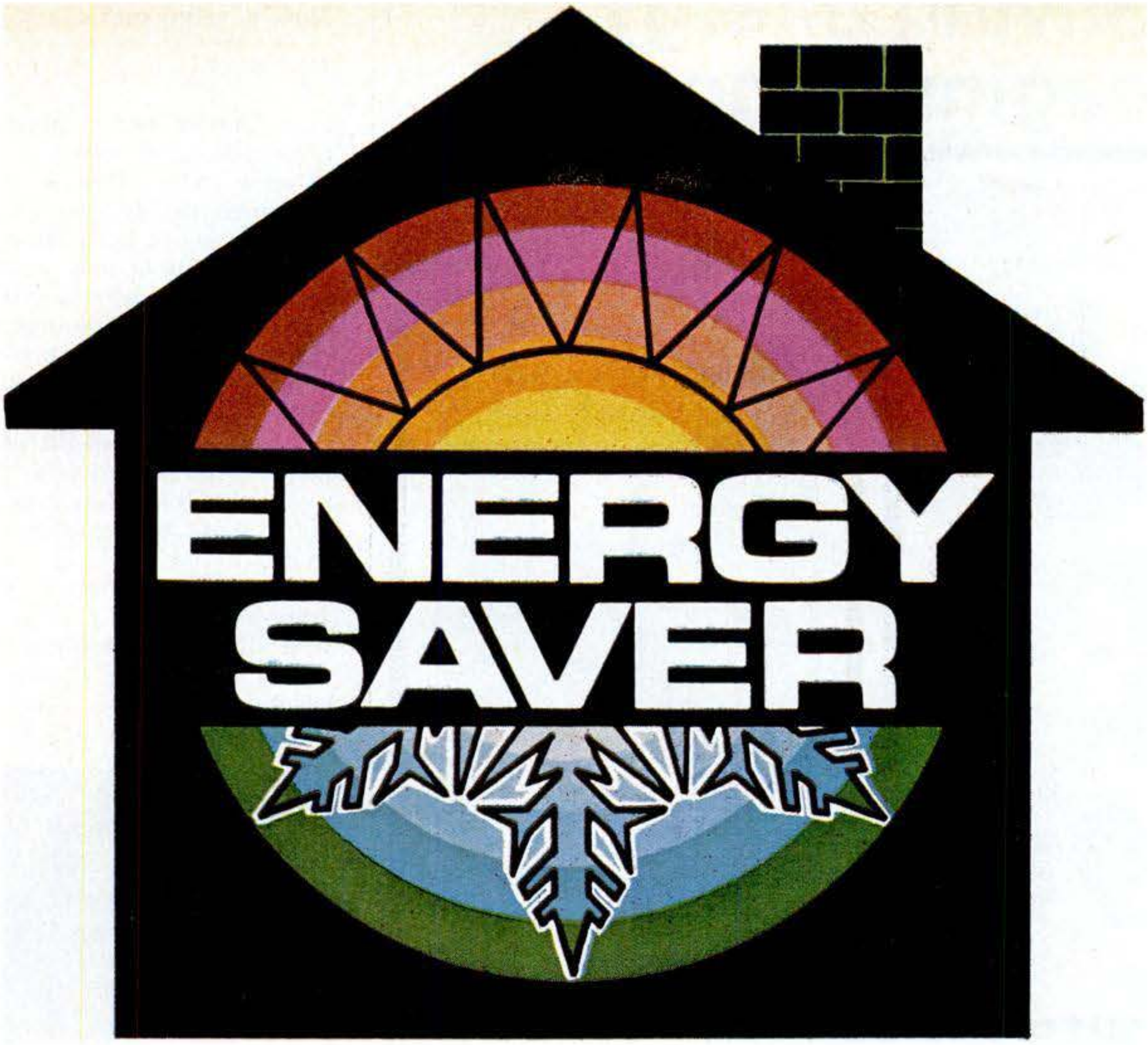

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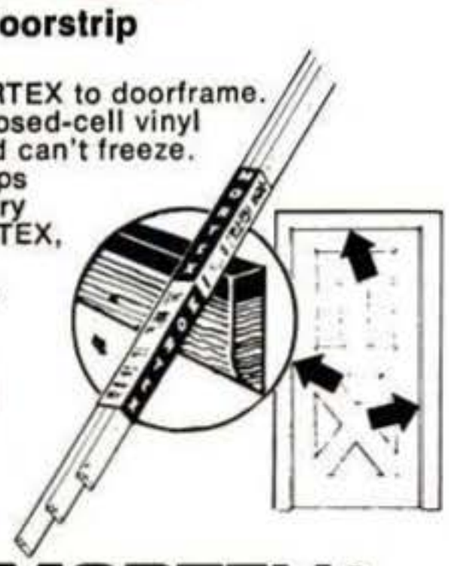

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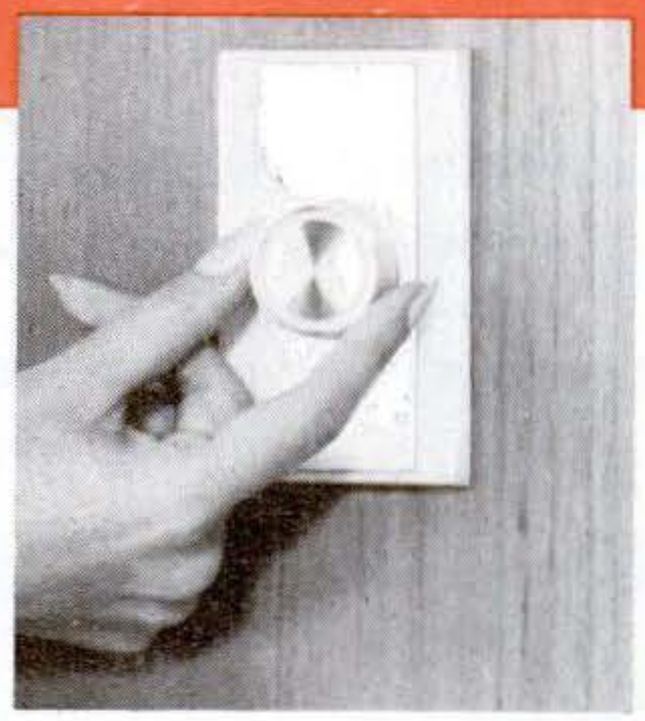

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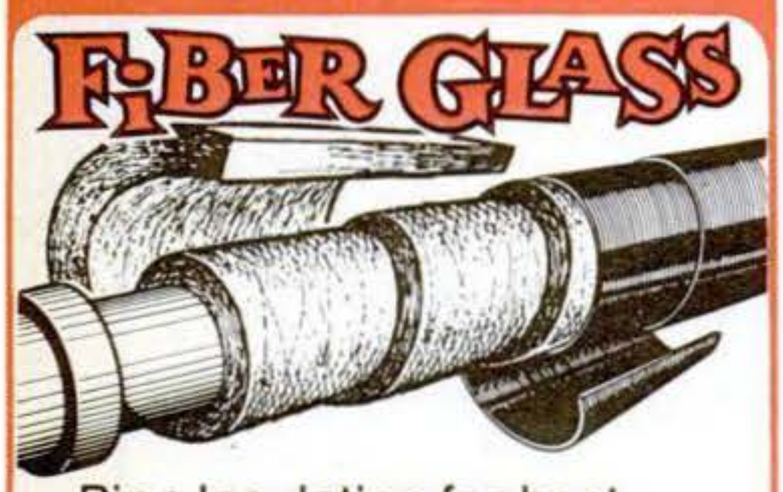

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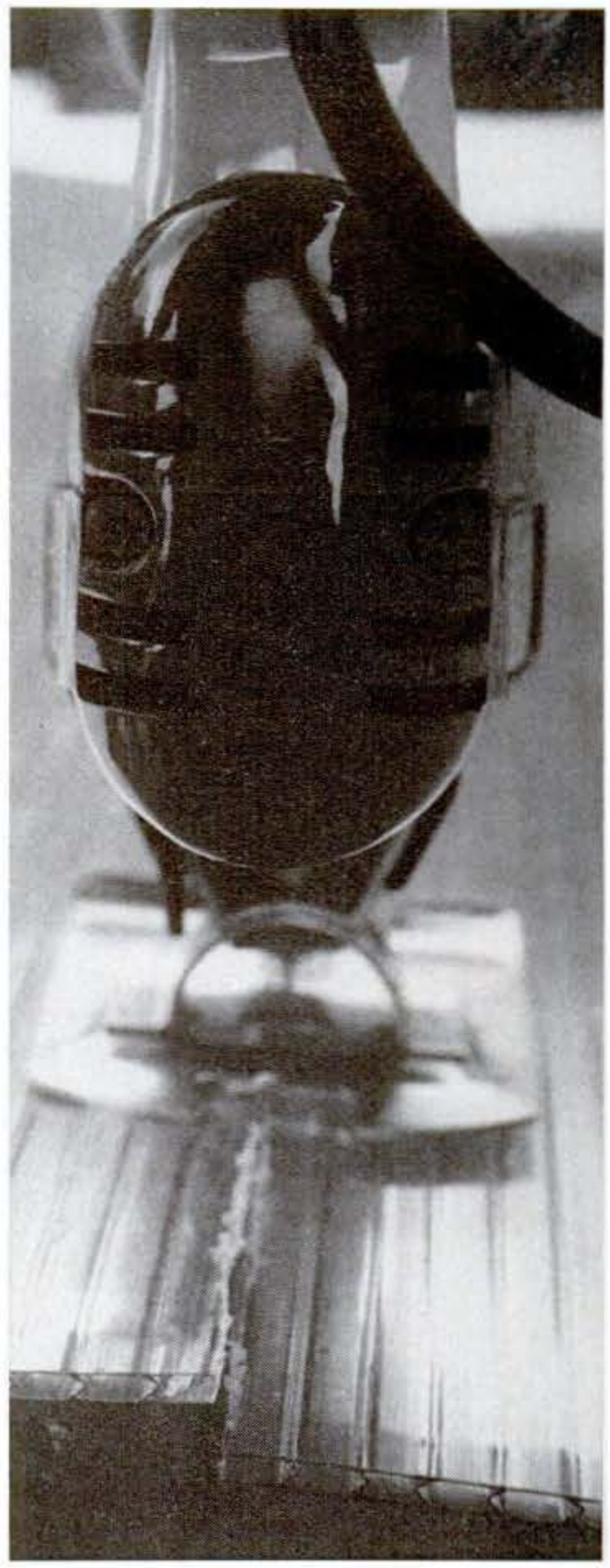
New glazing materials

[*Continued*]

tance of such factors as safety, long life, cost, and ease of handling. What's more, this is a rapidly changing, highly competitive field. There has not been time for independent tests of new products, and manufacturers promote their products hard. One manufacturer who combines basic glazing materials and sells them in double-window units told me he was bewildered by the way people could claim radically different criteria of performance, such as U-ratings, for products that were essentially the same.

Beyond the basic problem of trapping heat is a related one of what to do about ultraviolet light, which is a major problem for the plastics industry. (Glass is not harmed by UV.)



Cutting most plastics, as with this double-walled Tuffak-Twinwal sheet, is easy with saber saw or tin snips.

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New glazing materials

[*Continued*]

Only about two percent of sunlight falls in the ultraviolet part of the spectrum, but that's enough to tan a person's skin and raise havoc with expensive plastic films and sheets. Some formulations, such as acrylic sheet (Plexiglas) can stand up to all the sunlight they get, but cost makes them impractical for many applications.

It's still a buyer-be-wary market, but those interested in solar energy—active or passive—will find lots of tempting new products. Here's a look at some of the promising energy-related glazings now on the market. (The U-rating given is an expression of the total thermal value of the components of a building material. The lower the figure, the better.)

- *Tuffak-Twinwal* is a double-walled, hollow-channeled, polycarbonate sheet from Rohm and Haas. It is light in weight, about ¼ inch thick, costs around $1.35 per square foot, and has a U-rating of 0.62. Light transmission is "about 80 percent." It comes in four-by-eight-foot panels and can be cut with common tools, such as a saber saw. UV damages the sheets, however; a spokesman for Rohm and Haas says it will start to yellow in four to seven years. Useful life depends on the application and the amount of solar radiation, but the material is extremely tough—it can resist the impact of a five-pound steel ball dropped from 40 feet. To take advantage of the dead-air space, the edges must be sealed in the mounting process. As with other plastics, the material is combustible.

- *Sunwall* is an aluminum gridwork with Sun-Lite fiberglass-reinforced panels bonded to either side of it. A panel measuring roughly two-by-eight feet and about ½ inch thick costs $31.20 from Kalwall Corp., the manufacturer. Kalwall says the solar transmission is 77 percent and the U-value is 0.40. Kalwall sells different grades of its basic panel material; the best grade is called Premium II.

Kalwall also makes a grid system for thicker panels that has larger dead-air spaces; the company will make up new panels to a customer's specifications. A three-or four-layer panel, for example, might use Sun-Lite panels on the exterior surfaces for strength and Du Pont's Teflon film inside, for better solar transmission of 65 percent and a U of

Continued

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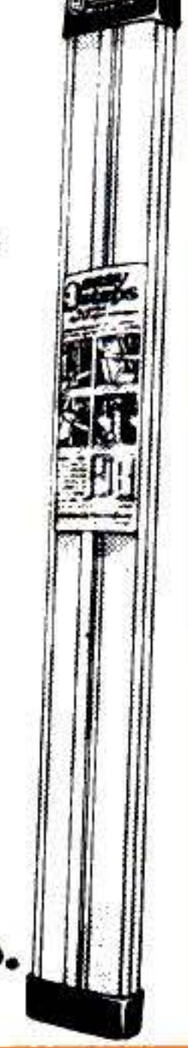

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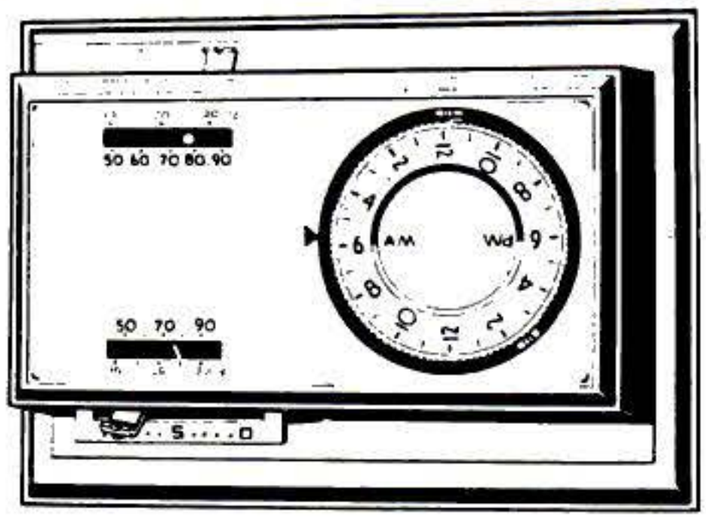

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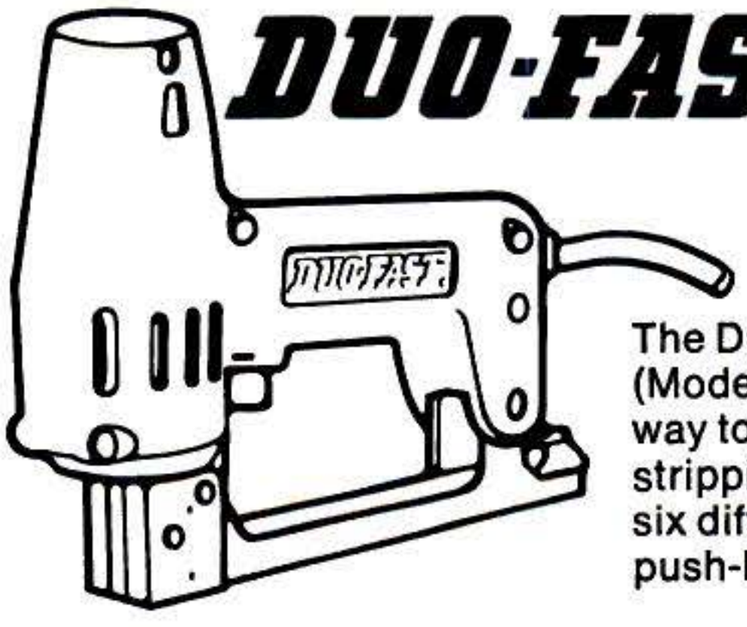

The Duo-Fast Electric Staple Gun (Model HE-5018) is the fast and easy way to install insulation, weather stripping and plastic sheeting. Drives six different staple sizes with push-button ease.

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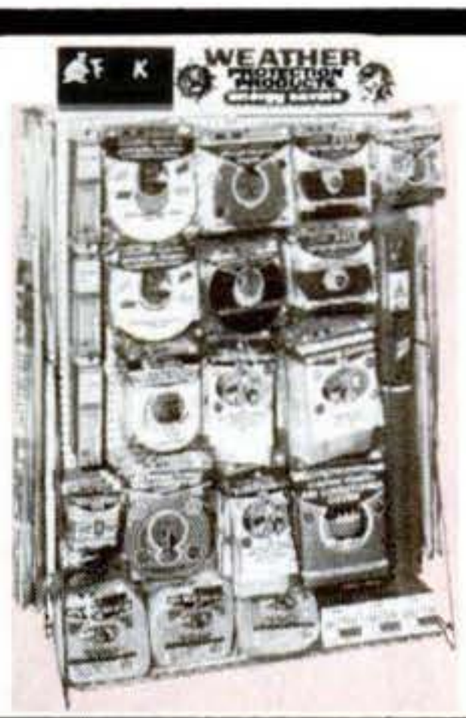

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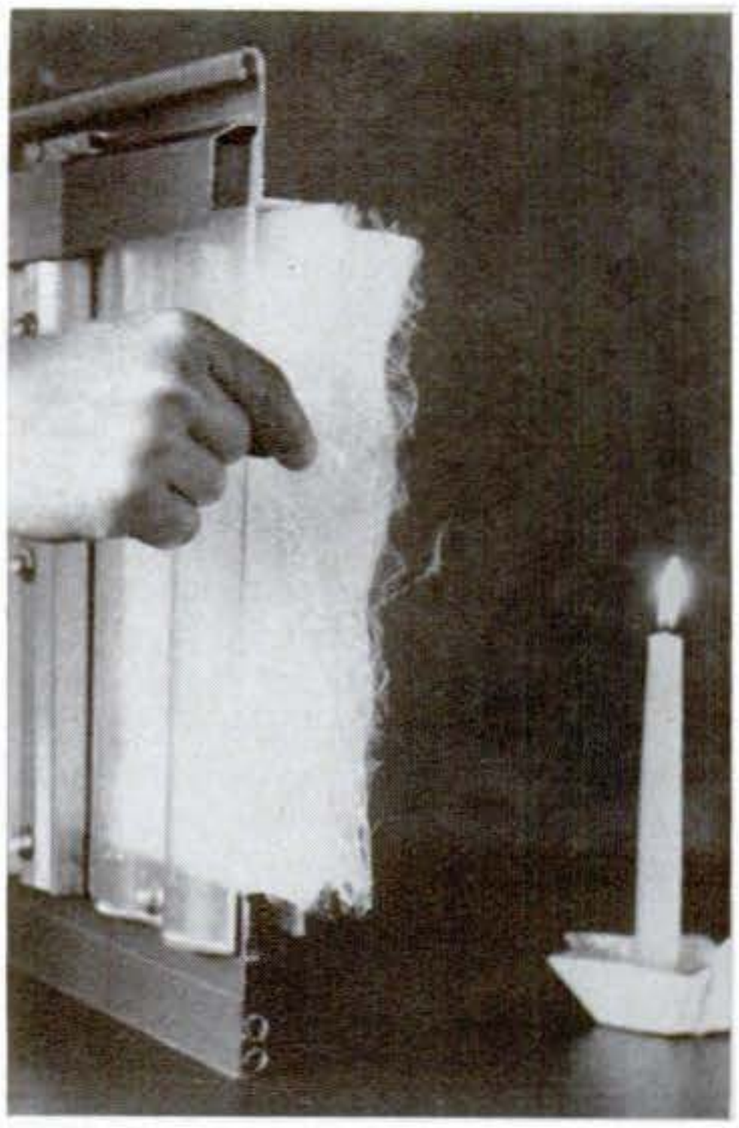

Fiber insulation between these fiberglass panels from Ind'l. Air and Light has U of 0.36, passes 30 percent of light.

0.26. Prices aren't available on these custom units, but I was told they would cost about 60 or 70 cents more per square foot, per layer, than the conventional two-layer Sunwall panels.

Sun-Lite premium panels are suitable for solar collectors because they can withstand 300° temperatures with only slight loss of solar transmission, according to a spokesperson for Kalwall. The manufacturer estimates the premium panels can withstand the sun for 20 years; the regular ones for seven years. Fire has been a problem with some fiberglass panels, but Kalwall's Premium II has an ignition temperature above 950°. Fiberglass panels don't shatter, and generally have an impact strength much greater than that of glass.

• *Twindow Xi* is a relatively new insulating-glass product from PPG Industries. Two pieces of glass are fused together; the 3/16-inch space between them is filled with a dry gas for better insulation.

A conventional window by the same manufacturer—also with a 3/16-inch air space—has a U of 0.67, while the Twindow Xi unit has a U of 0.55. (Similarly low U-ratings can be obtained with a larger dead-air space. ASG Industries, for example, says its insulating window with a ½-inch dead- air space also has a U of 0.55.)

• *Triple Thermopane* from Lib-

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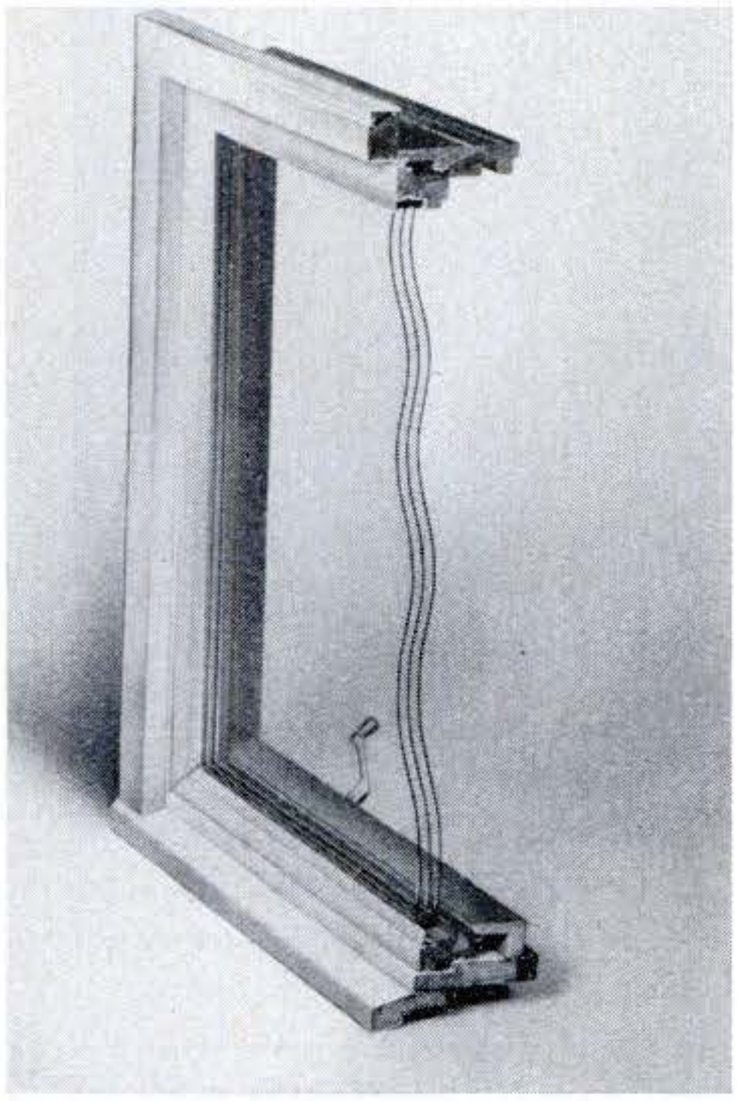
New glazing materials

[*Continued*]



Triple-glazing is now available in a few top-quality windows. Inch-thick pane (Nat'l Woodwork Mfrs.) has 0.425 U.

bey-Owens-Ford is produced with two ¼-inch dead-air spaces for a U of 0.39) or two ½-inch dead-air spaces (for a U of 0.32). Double-glazed windows [PS, Sept. '75, Oct. '75] have been shown to be worth the investment, but whether triple-glazing is worth the extra cost depends on how cold it is where you live and your energy costs. Relatively few window manufacturers are triple-glazing; some are producing triple-glazed windows only in the far northern areas of the country where they may prove their value. (PPG's version is triple Twindow.)

• Industrial Air and Light, Inc., makes large fiberglass windows that incorporate different insulating materials between the panels. These are not really suitable for residential applications, I was told by William Voegele, the firm's president. Still, the concept is worth noting. One of the windows uses an eight-ounce corrugated fiberglass panel on the outside and a flat, fiberglass panel on the inside, with 1½ inches between them. Left empty, this panel has a U of about 0.60 and lets in about 60 percent of the sunlight, says Voegele. When filled with a spun-glass insulation (angel hair), the light drops to about 30 percent and the U to 0.36.

"We're also experimenting with a cellular plastic sheet for insula-

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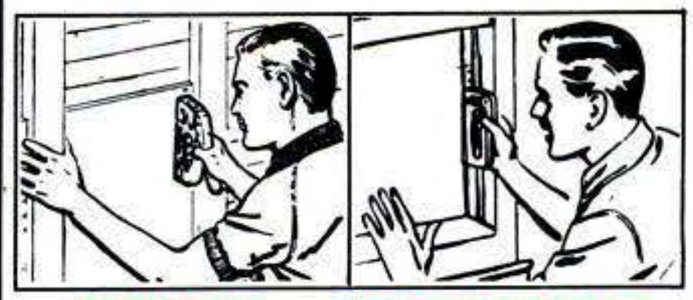

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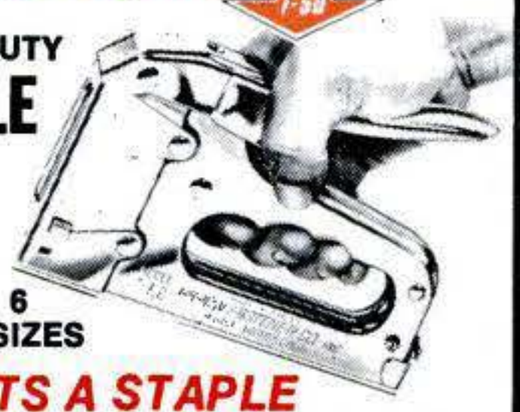

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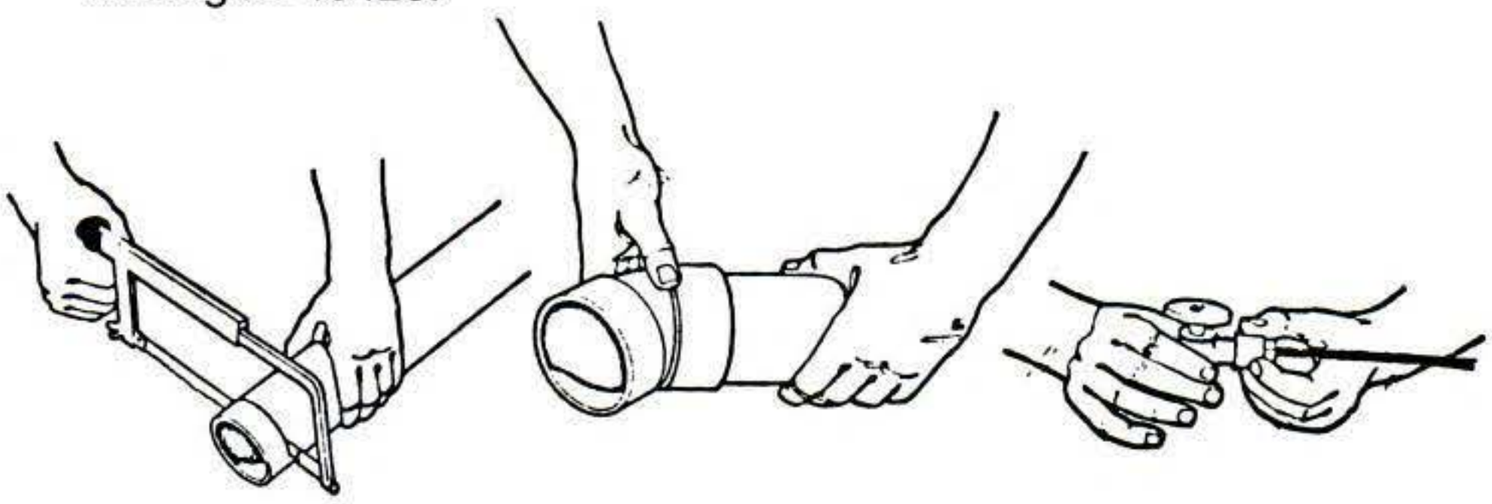

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New glazing materials

[*Continued*]

tion, like the stuff used for packing. We figure this has a U of 0.30 and light transmission of about 50 percent," Voegele says. But the cost also rises. To keep the plastic insulation from deteriorating, fiberglass panels with Du Pont's Tedlar film bonded to them are used. The Tedlar acts as a UV screen.

● *Lascolite* insulated skylight panels are made by Lasco Industries, Inc. They comprise two layers of fiberglass with a layer of light-transmitting foam between them. They are designed to provide natural light for indoor tennis courts (light transmission is 42 percent). The argument is that what is lost in heat (the U is 0.53) will be gained in a lower artificial-lighting bill.

Continued

Geodesic-dome greenhouse by Semisphere of Richmond, Va., is covered with Tuffak-Twinwal—a double-walled polycarbonate sheet that provides extra insulation while still allowing 80 percent of sunlight to pass through.

Quick guide to common glazing materials

Common glazing materials fall into two categories, glass and plastics.

Glass, used in windows since the time of the ancient Romans, is the standard by which other materials are judged. Many plastics are better than glass in one category or another, and this is why they are used in special instances. But there is no single material with so many good characteristics as glass.

Thus low-iron tempered glass makes a good solar-collector cover; double-weight glass is used extensively in greenhouses; and insulated glass is still the prime choice of the energy-conscious homeowner for windows. The qualities of glass that most frequently make it first choice are its unchallenged long life, clarity (many plastics are milky, so aren't suitable for windows), and cost.

Still, the claims of longer life in some of the new films and fiberglass-reinforced panels are enticing. The plastic products offer special advantages that can make them better than glass in particular situations requiring special applications.

Manufacturers' claims vary, and some newer formulations are trade secrets, making it difficult to categorize them precisely; but here's a rough-and-ready guide to commonly used glazing materials.

● *Polyethylene.* Cheap, readily available, and stronger than glass, polyethylene comes in large sheets and is an effective heat-loss barrier if double-layered with a dead-air space between layers. Life span is one to three years, depending on degree of exposure to sunlight and quality of material. Light transmission is 85 to 90 percent, but a milky appearance makes it a poor choice as even a temporary storm window, since this milky quality obscures the view.

● *Vinyls.* These films cost more than polyethylene, are usually clear, and have a longer life span (two to five years). They are damaged by the sun's ultraviolet rays. Vinyl is made in comparatively narrow sheets (less than 10 feet, compared with 40-foot-wide polyethylene), and tends to collect dust and dirt electrostatically.

● *Polyvinylfluorides.* Du Pont's Tedlar is the best-known film in this category. It is finding some applications in solar collectors and as an ultraviolet screen bonded to fiberglass panels to improve their life span.

● *Acrylic.* Long life, clarity, and superior strength are pluses; high cost a minus. Since there's good visibility through acrylic (although it can be made milky or tinted) it is frequently used as a substitute for glass when safety and resistance to breakage warrant it (storm doors or skylights, for example). As a solar-collector cover, acrylic sags at high temperatures; the temperatures in excess of 300° that may be reached in a stagnant collector are the ones you use to start bending acrylic into interesting shapes. Acrylic expands and contracts with changing temperatures, so it shouldn't be nailed or screwed down tight.

● *Fiberglass.* This name covers a multitude of panels of different mixtures of resins and glass fiber and of widely varying performance and price. It is generally sold in flat sheets four feet wide, or corrugated panels about two feet wide in lengths of 20 or more feet. The "clear" (not colored) panels have various solar applications. Visibility through them is poor, but solar transmission is generally good. Life spans of five to 10 years are the norm for the more common types, but Tedlar-coated greenhouse panels are said to last 20 years, and some panel manufacturers who don't use Tedlar now say their special formulations result in a panel which will last equally as long. Cost is competitive with glass (if life span is ignored) and the large panels can be easily cut, nailed, or screwed in place. They require less supporting framework —and diffused light is an advantage in greenhouses.

Corrugated panels are usually advised for roofs because of their greater strength, but remember that all those corrugations mean that more total area is exposed to the cold air than if a flat pane were used. Consequently, heat loss over a given span will be greater with the corrugated material.

Fiberglass is being used in greenhouses, cold frames, solar walls, and as solar-collector covers. How well it can stand the heat buildup in a collector that runs dry depends on the individual fiberglass, but it is generally not as good as tempered glass in this respect. Visibility through fiberglass is poor, but solar transmission is good. The high solar transmission and strength of fiberglass has made it attractive to collector builders, especially where the unit is not expected to build up excessively high temperatures. Plastics, it should be remembered, are combustible, and most fiberglass burns rapidly.

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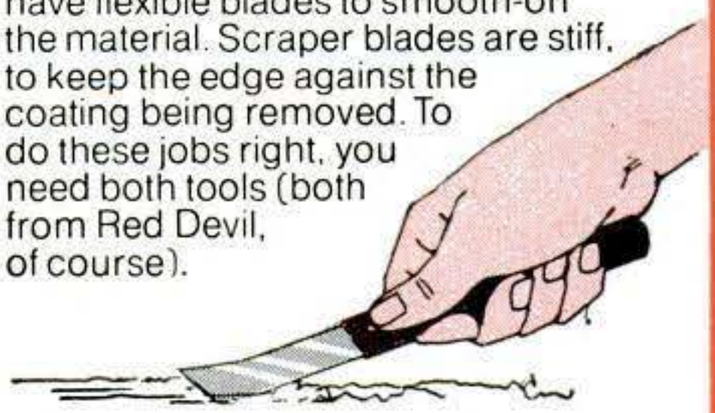
A putty knife is not a scraper. And vice versa. Putty knives (for spackling walls and puttying windows) have flexible blades to smooth-on the material. Scraper blades are stiff, to keep the edge against the coating being removed. To do these jobs right, you need both tools (both from Red Devil, of course).

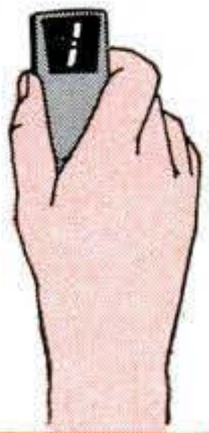


Caulk is caulk is caulk? Wrong! Latex or acrylic latex caulk provide excellent durability (especially when painted) and easy clean-up for most uses, but you'll need butyl caulk for the water resistance required at or below ground level. Different caulks for different jobs, that's why Red Devil offers different kinds.

Bag your paint brush. Don't throw away the plastic cover when you buy a new paint brush. It'll keep the brush dust-free and in perfect shape between uses. Red Devil brushes come with re-sealable covers for just that reason.

Bargain paint rollers can cost you more. Those cheap one-piece roller and cover combinations often don't put enough paint on the wall or put it on unevenly. The results? You'll have to buy more paint to apply an extra coat. Better roller covers (like Red Devil's) will help you get the most "mileage" out of your paint.

Stud finders are un-holey. When hanging pictures on a freshly painted or papered wall, don't fill it with holes before you find the wood behind it. Use a Red Devil Stud Finder. It points out where nails are—and where there are nails, there are studs.



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New glazing materials

[*Continued*]

● *Beadwall* is a system in which Styrofoam beads are blown between transparent walls at night, when more insulation is wanted, and sucked out when more sunlight is desired. It takes about a minute to fill or empty a six-by-eight-foot panel. Used with Kalwall's Sunwall, this system has a U of 0.40 when the beads are evacuated and a U of 0.10 when they are in place. (The system could be used with walls of other construction.) Beadwall systems are made by Zomeworks of Albuquerque, N.M.

● *Flexigard* from 3M isn't a double-walled product; it's described as "a composite plastic film with the light-transmission and insulating properties of glass." It has three claimed qualities that set it apart from run-of-the-mill films: long life, clarity, and high cost.

Designed for use in greenhouses, storm windows, and solar collectors, Flexigard was tested in Florida for 10 years and "showed no signs of degradation," said Don Flentje of 3M.

The most commonly used film in the greenhouse market today is polyethylene. The longest lasting variety is Monsanto's 602, which will last at least two years before ultraviolet significantly discolors and weakens it. It costs about three to four cents a square foot. (Incidentally, double-layering is used extensively in the greenhouse business, where polyethylene is almost always applied in two layers and frequently in an air-inflation system that uses air from a small blower to keep the two layers separated.)

Flexigard, however, one variety, costs about 35 cents a square foot. It comes five mil thick in rolls 48 inches wide and 150 feet long. (If you want to experiment with this material, you can obtain a four-by-10-foot sheet for $25 on a one-order basis by writing D. H. Flentje, 3M Co., 3M Center, Building 233-2, Special Enterprises Department, St. Paul, Minn. 55101.)

Flexigard's longer life and clarity (polyethyelene and many other plastics aren't optically clear) make it more suitable as a storm-window material. Like most other films, it can be sliced by knife, but it's surprisingly tough and resilient for fending off missiles, such as an errant football.

● *Sunadex*, a low-iron glass, isn't new, but the energy crisis has focused new attention on this ma-

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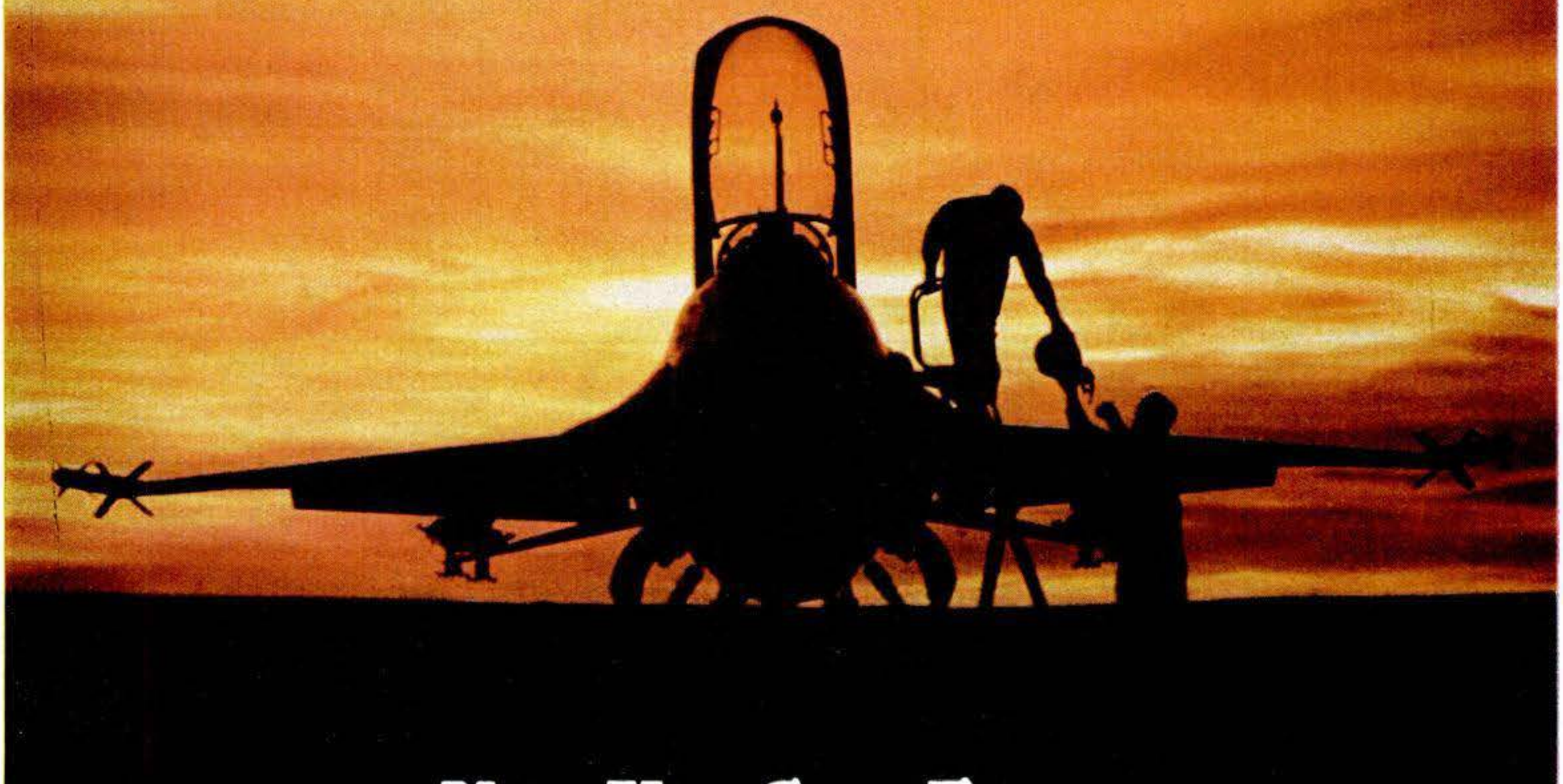

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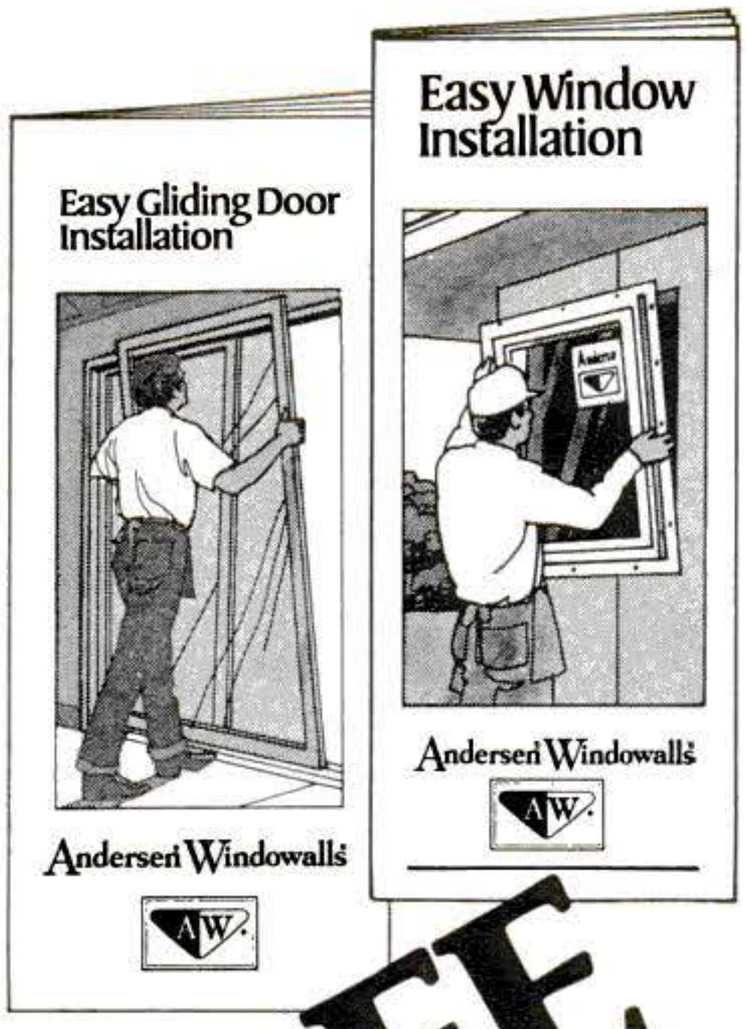

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New glazing materials

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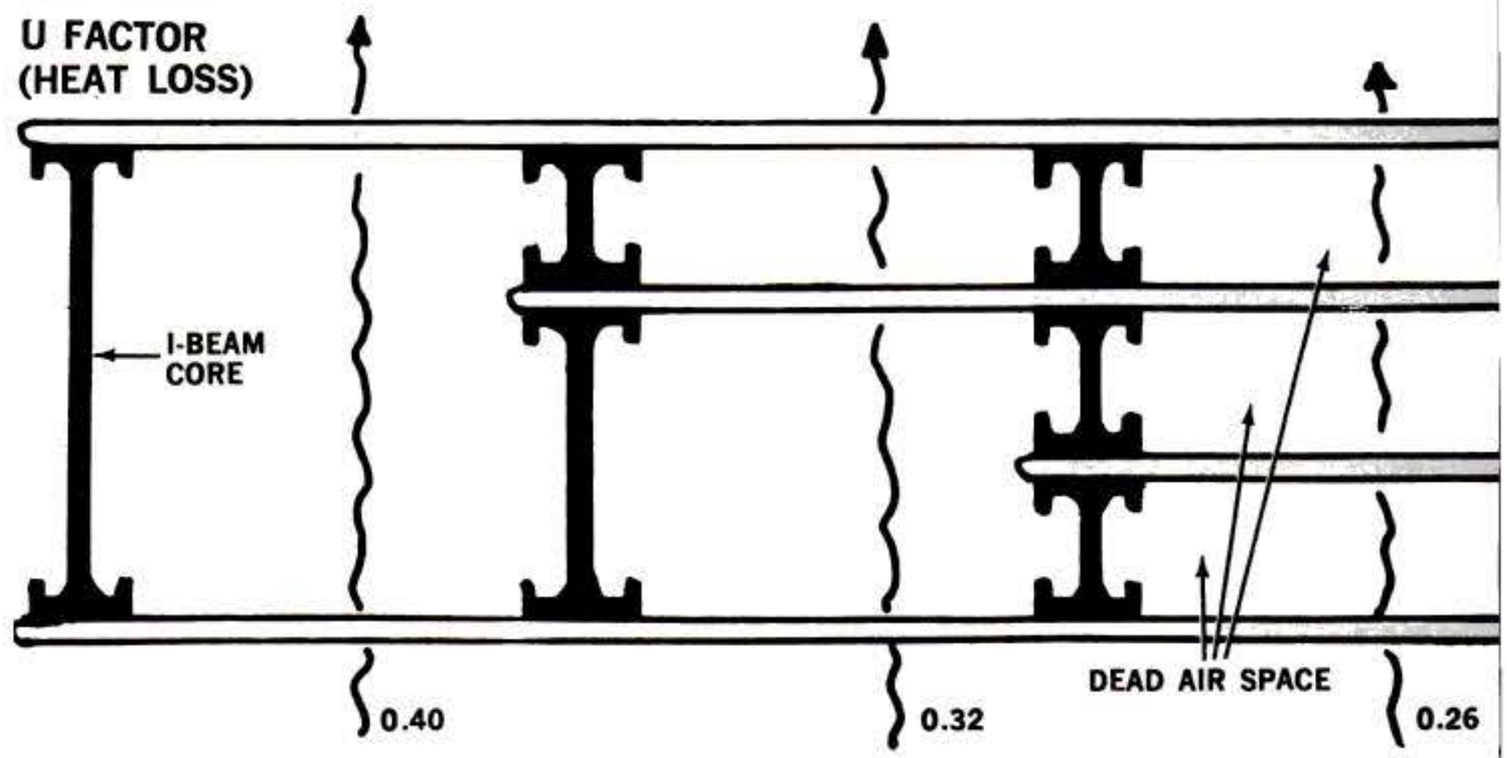

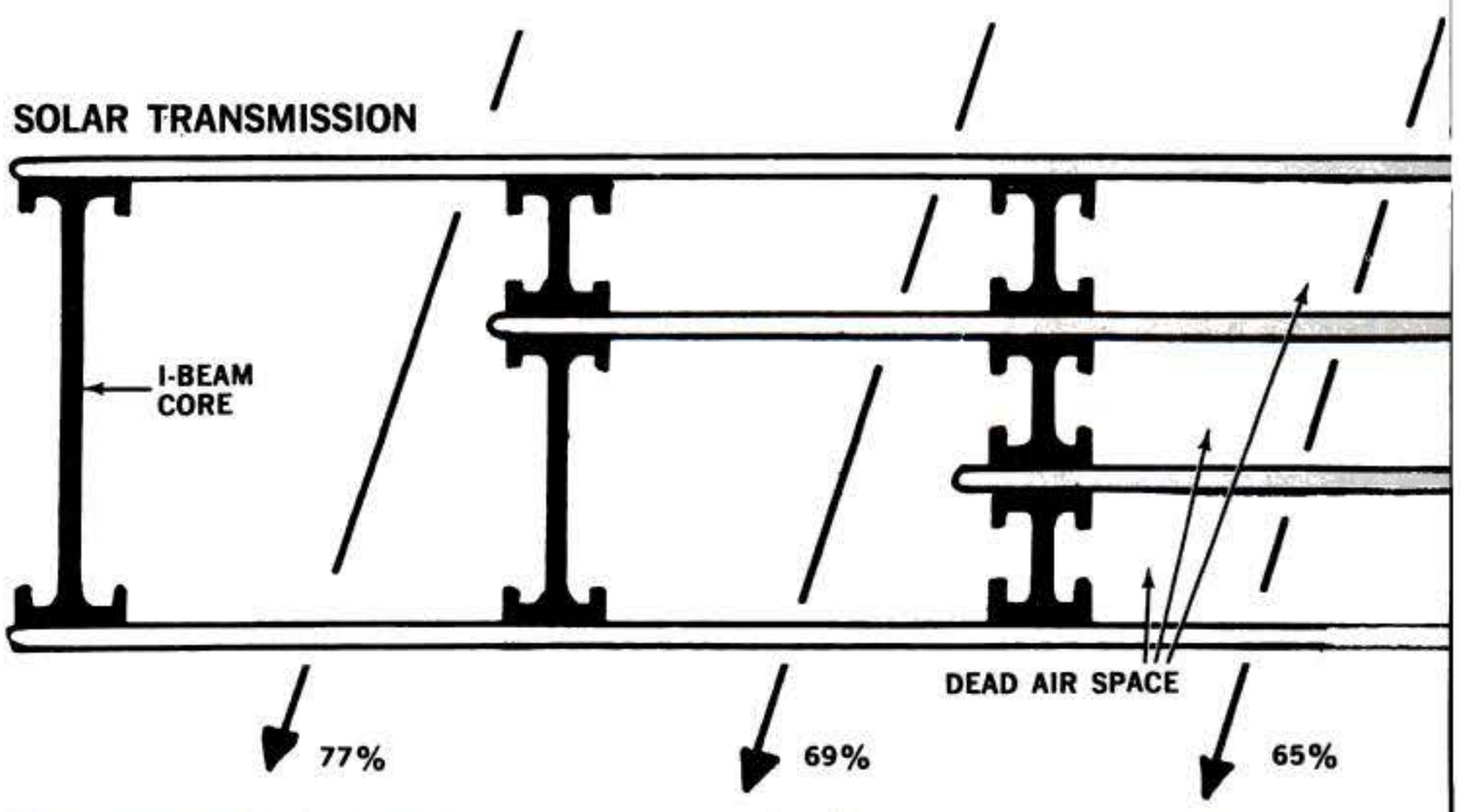

Solar transmission and heat losses, according to number of walls, are shown in Kalwall drawing of fiberglass-reinforced polymer face sheets.

terial, which ASG Industries has been quietly making for more than two decades. Apparently no one else is making a glass with an iron oxide content as low as Sunadex (0.01 percent), and that's the key to its attractiveness as a solar-collector cover. Low iron content means good solar transmission, which here is over 91 percent. That's money in the bank, as one rival solar engineer points out: The increased transmission shows up directly in the increased efficiency of the collector. In comparison, Starlux, an ASG glass with a more typical iron content of 0.12 percent, has a solar transmission of 84 percent. (These transmission figures are for glass ⅛ inch thick.)

As may be expected, you pay a premium for Sunadex, for it costs about 70 percent more than glass with a higher iron content. "But it's worth it," argues ASG's Clarence Clarkson, "because the glass cover is a relatively small part of the total solar-collector cost." He says the extra solar transmission really shines in collectors that use double glazings, as many do today.

Glass used in collectors should be tempered for greater strength and resistance to heat shock. If collectors stagnate (run dry), the heat can build up well above 300°. Plastic covers can sag, and ordinary glass can crack. Sunadex may not find its way into your home windows, but it's the sort of product that's catching on as an energy-conscious nation tries to grab a little "free" heat directly from the sun. PS

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ASG Industries, Box 929, Kingsport TN 37662; **Dipcraft,** 11 W. Braddock Ave., Braddock PA 15104; **Du Pont,** Rm. 24751, Nemours Building, Wilmington DE 19898; **Filon Div. of Vistron,** 12333 S. Van Ness Ave., Hawthorne CA 90250; **Glasteel,** 2200 W. Emerson Place, Seattle WA 98199; **Industrial Air and Light,** 20 Bridge St., Pittsburgh PA 15223; **Kalwall,** 111 Candia Rd., Box 237, Manchester NH 03105; **Lasco Industries,** 3255 E. Miraloma Ave., Anaheim CA 92806; **Libbey-Owens-Ford,** 811 Madison Ave., Toledo OH 43695; **Monsanto,** 20 N. Eighth St., Kenilworth NJ 07033; **Nat'l Woodwork Mfgrs. Assn.,** c/o SR&A, 355 Lexington Ave., New York NY 10017; **PPG Industries,** One Gateway Center, Pittsburgh PA 15222; **Rohm and Haas,** Independence Mall West, Philadelphia PA 19105; **Sheffield Poly Glaz,** Sheffield MA 01257; **Sto-Cote Products** 2139 N. Wayne Ave., Chicago IL 60614; **3M** 3M Center, Building 223-2, Special Enterprises Dept., St. Paul MN 55101; **Zomeworks,** Box 712, Albuquerque NM 87106.

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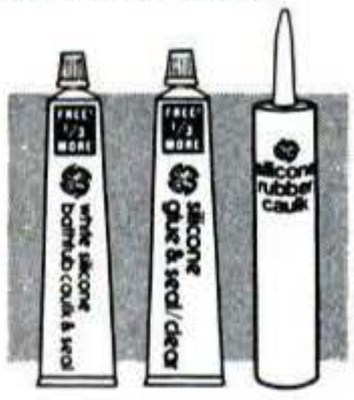

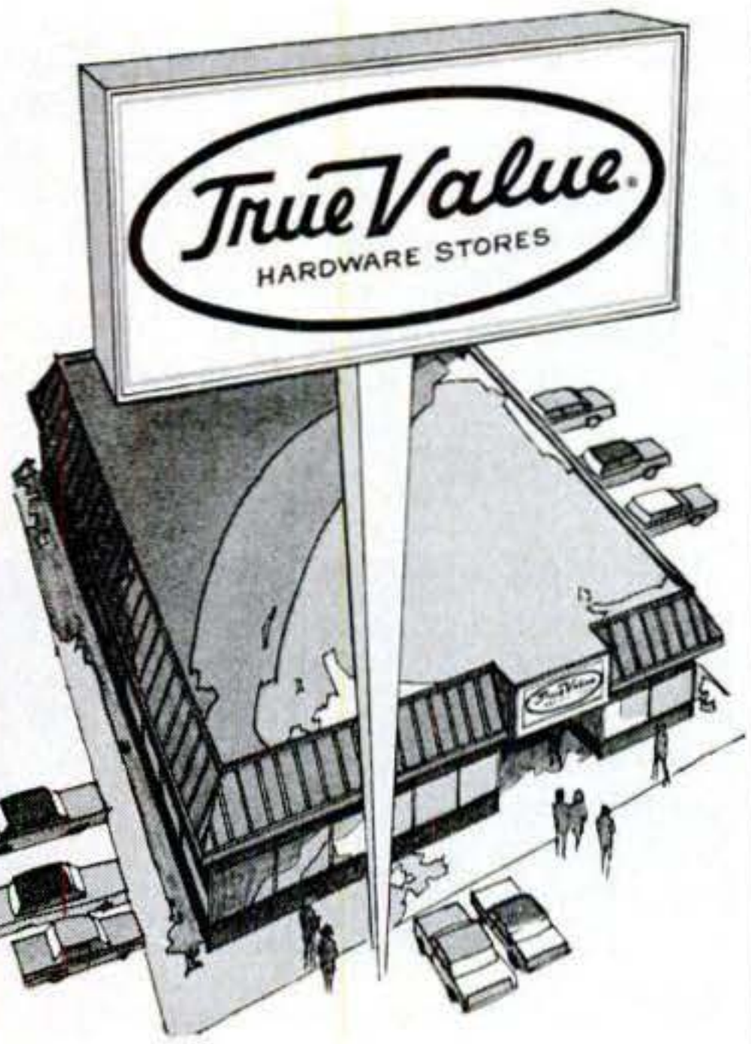

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GENERAL ELECTRIC

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DIY picture window

Custom-sized, double-glazed panes are now available for your own custom-built picture window

By RICHARD STEPLER

Want a picture window to frame a view but concerned about the energy-wasting potential of a large expanse of glass? Of course, even large sheets of glass can be double-glazed, but the cost—especially if you're worried about accidental breakage—is frequently prohibitive.

Here's a way to have your view, keep the cost reasonable, and save energy at the same time. You build this picture window yourself, from scratch, and the glazing—Weatherpane insulating glass panels—is custom-made to your order by PPG.

Weatherpane panels consist of two pieces of glass separated by a spacer tube around the edges. The enclosed air space is hermetically sealed. A drying agent in the spacer tube keeps the entrapped air dehydrated.

Architect Robert Dale Lynch of Coraopolis, Pa., designed this picture window for the dining room of a colonial home near Pittsburgh. In keeping with the home's design, the window has a colonial flavor: 35 individual Weatherpane insulating units, each measuring 11-5/16 inches square, are set in a pine frame to enhance the period look. Overall size of the picture window: just over five feet high by seven feet wide.

A wall-to-wall window seat provides storage space and ensures that the picture window and the rustic, wooded view it frames will be the focal point of the dining room.

Construction

Unlike most scratch-built windows, this one—if carefully built—will be as draft-free as the expensive, factory-made double-glazed windows.

First step is to provide a rough opening for the picture window. For the 35-pane window shown, you'd need an opening 7′ 5-9/16″ wide by 5′ 4¾″ high (see drawing on the following page). Doubled 2-by-10's span the opening at top, and doubled 2-by-4's provide sill and side jambs.

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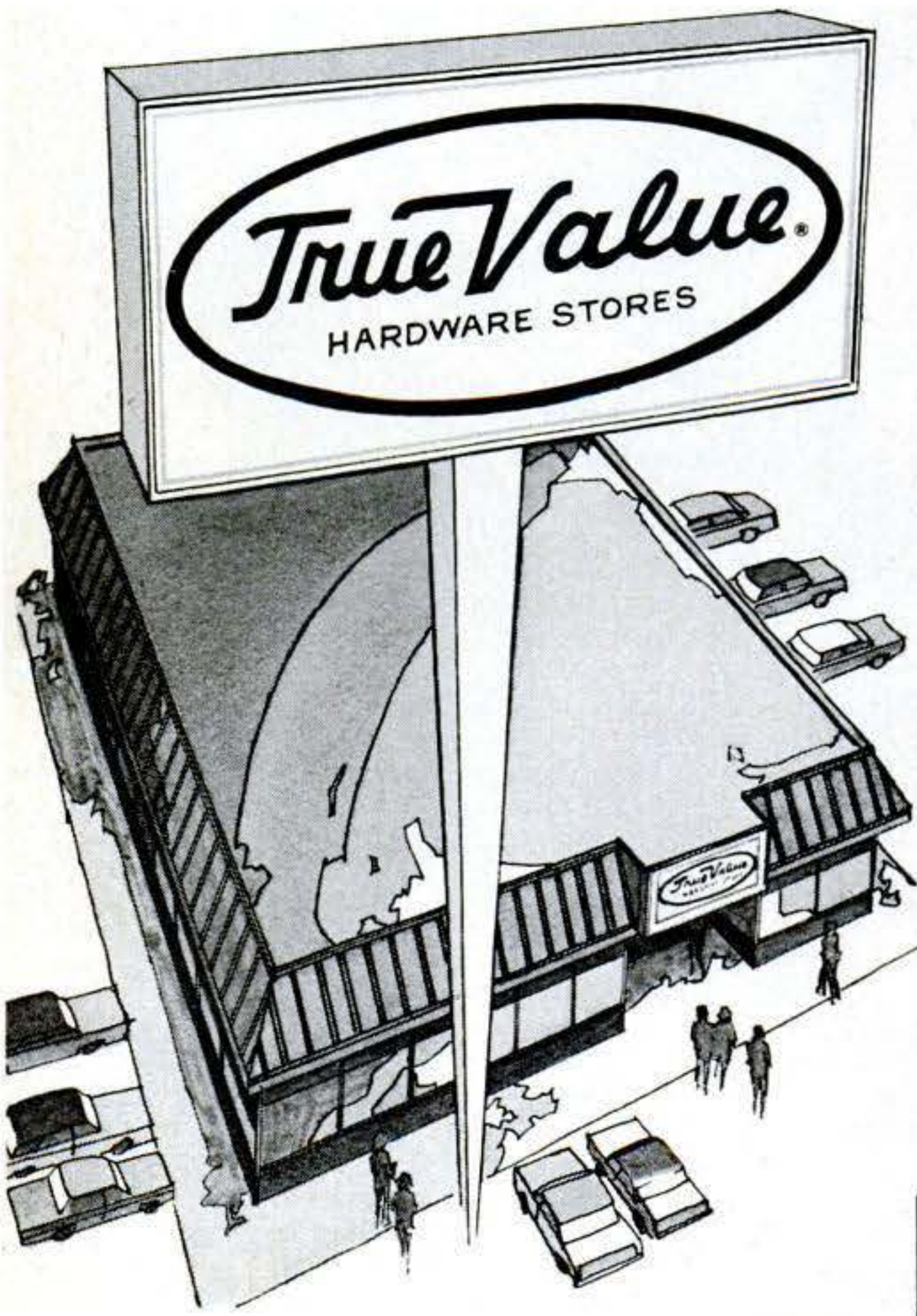

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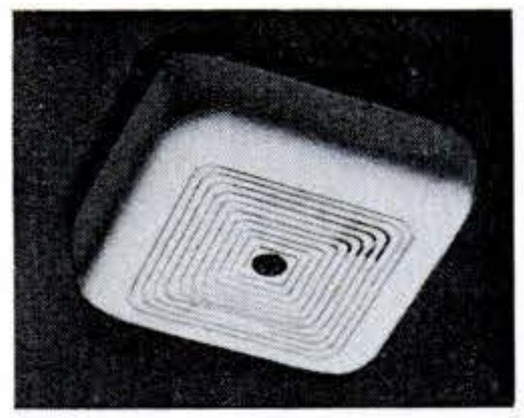

Save on locks, lighting, GE smoke alarms, every home security need—plus dozens of other values in our new 1977 Spring & Summer Catalog. Watch the mail or ask for it at your participating True Value Hardware Store.

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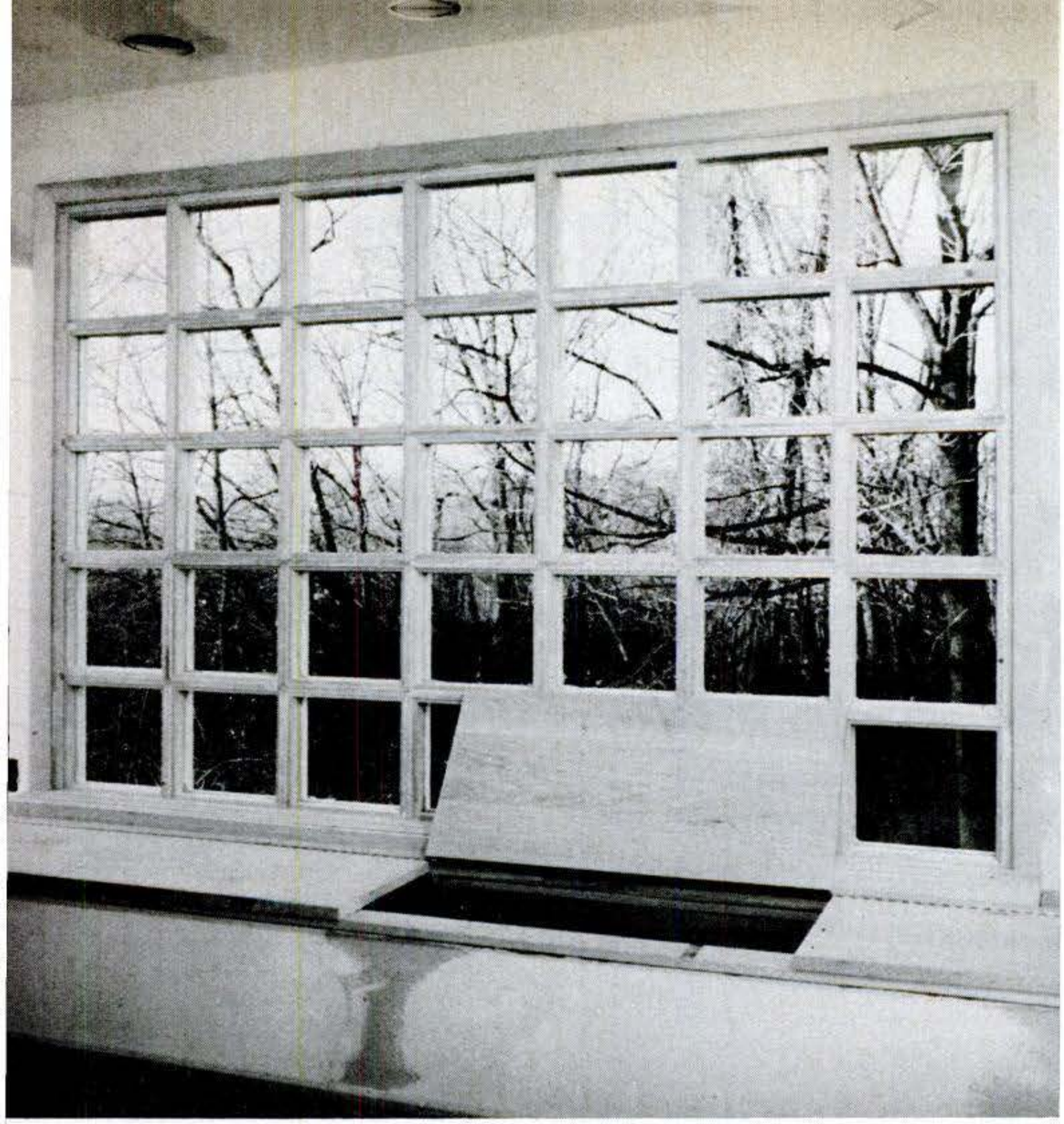


Glazing sealant is applied to outer stop before double-glazed Weatherpane units are set in place.

Colonial-style picture window replaced two widely spaced double-hungs. Window seat has piano-hinged top panels for access to storage.

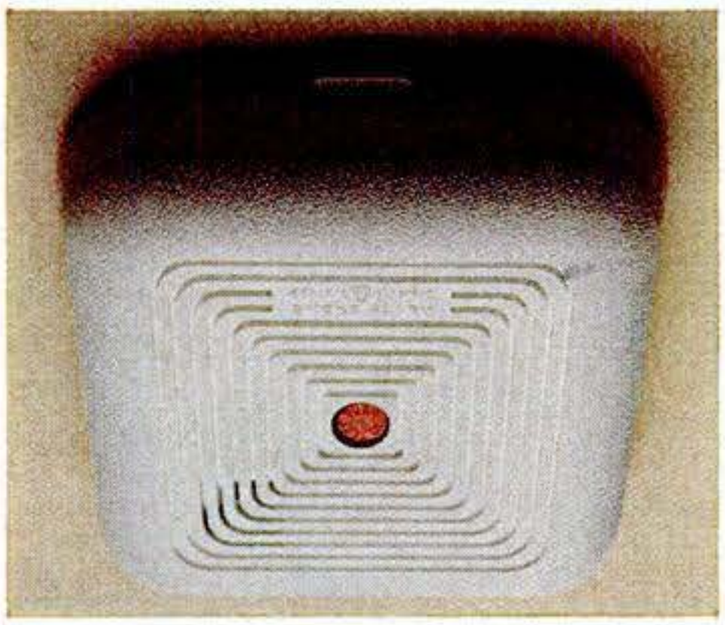
Deciding which smoke alarm to buy could be one of your most important decisions.

Here's why you should decide on the Home Sentry® Smoke Alarm from GE.

The Home Sentry Smoke Alarm from GE is an early-warning system that "sniffs" the air for the presence of smoke and sounds an alarm when smoke reaches it. It is the brand more families bought in 1976 than any other. We think there are some good reasons why.

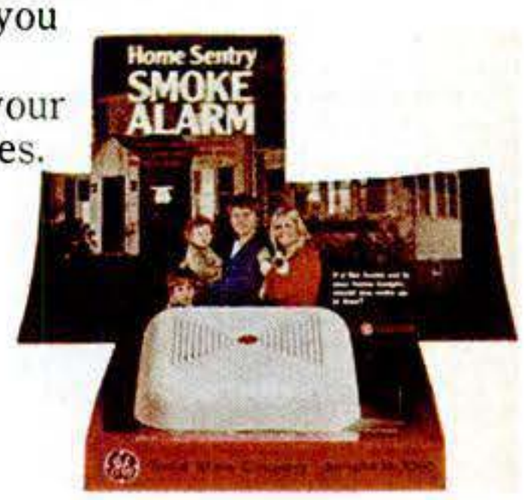
The battery-operated Home Sentry Smoke Alarm is the *only* smoke alarm with a 3-point checking system to assure you the alarm and the entire system are in working order. It features a 12.6-volt Duracell® battery made especially for smoke alarms by P. R. Mallory & Co., Inc. And because it's battery-operated the Home Sentry Smoke Alarm can continue to function even if household power fails.

Of course, there's no way to



guarantee against injury or loss of life in a fire; however, the Home Sentry Smoke Alarm from GE is intended to help reduce the risk of tragedy. And every Home Sentry Smoke Alarm is backed by the General Electric name and the quality and reliability it stands for.

The Home Sentry Smoke Alarm can be installed with common household tools. For more details, see your local GE dealer. Now's the time to buy one—or as many as your home may need. The Home Sentry Smoke Alarm could help you save your home and your family's lives.



GENERAL ELECTRIC

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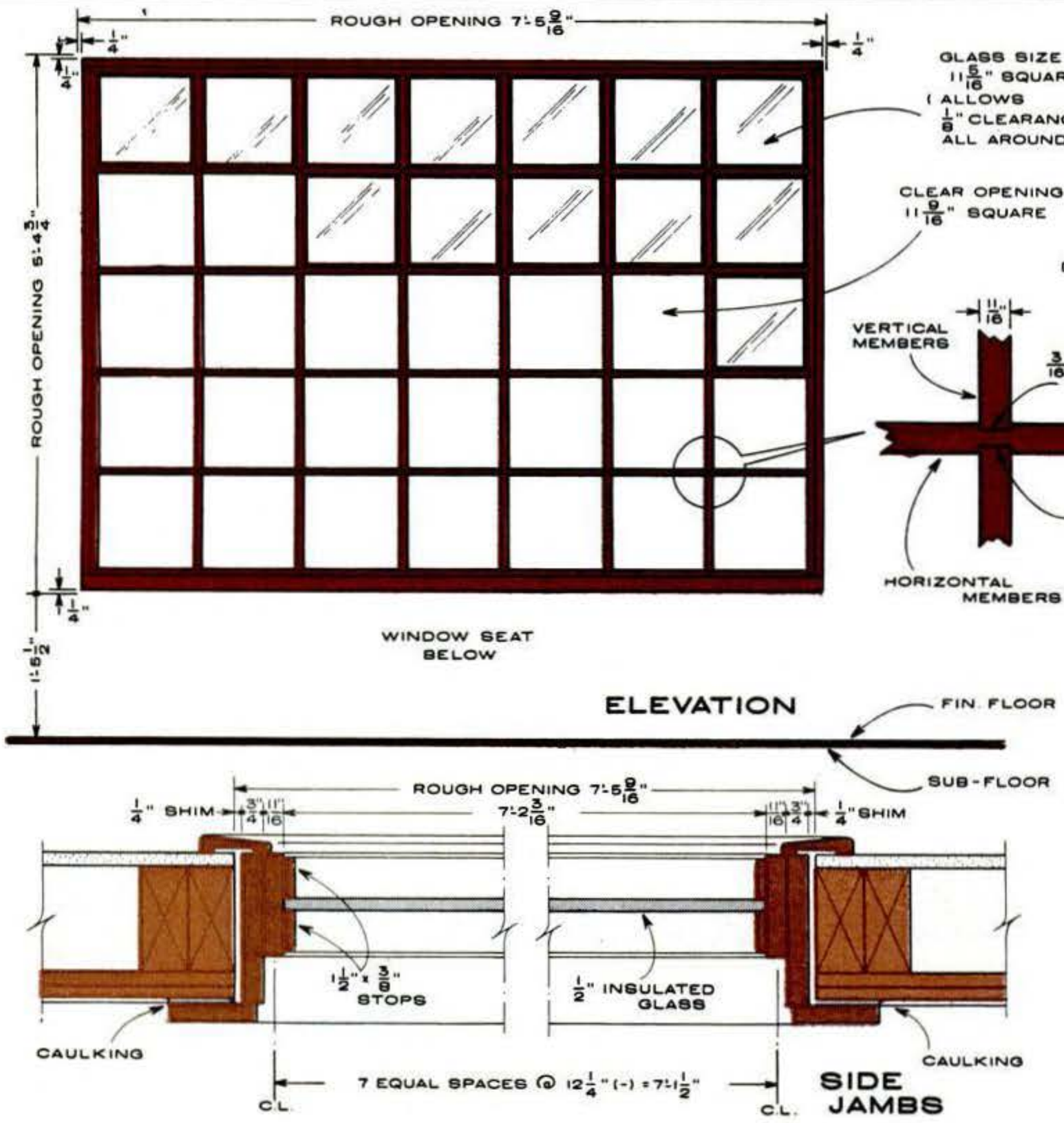
[*Continued*]

The picture window's pine frame is made from 1"-by-3⅝" (1-by-4) stock. Use clear pine. Six 7′ 1½"-long pieces are dadoed to provide snug joints for the 30 12¼"-long vertical members (see detail on drawing).

With the frame in place, install the outer glass stops. These are made from ⅜"-by-1½" clear pine, 12¼" long, both ends mitered. You'll need 280 separate pieces for the window shown; cutting them in multiples—as many as your radial-arm or table saw can handle—will speed the operation.

Outer stops in, install the Weatherpane panels as shown in the photos. Approximate cost of Weatherpane glass is $5 per sq. ft. For more information write PPG Industries, One Gateway Center, Pittsburgh, Pa. 15222. PS

Weatherpane unit is snugged in place against glazing bead around outer glass stops of ⅜"-by-1½" stock lumber (left). Final step: installation of inner glass stops (right). Construction provides an air-tight, insulated picture window.



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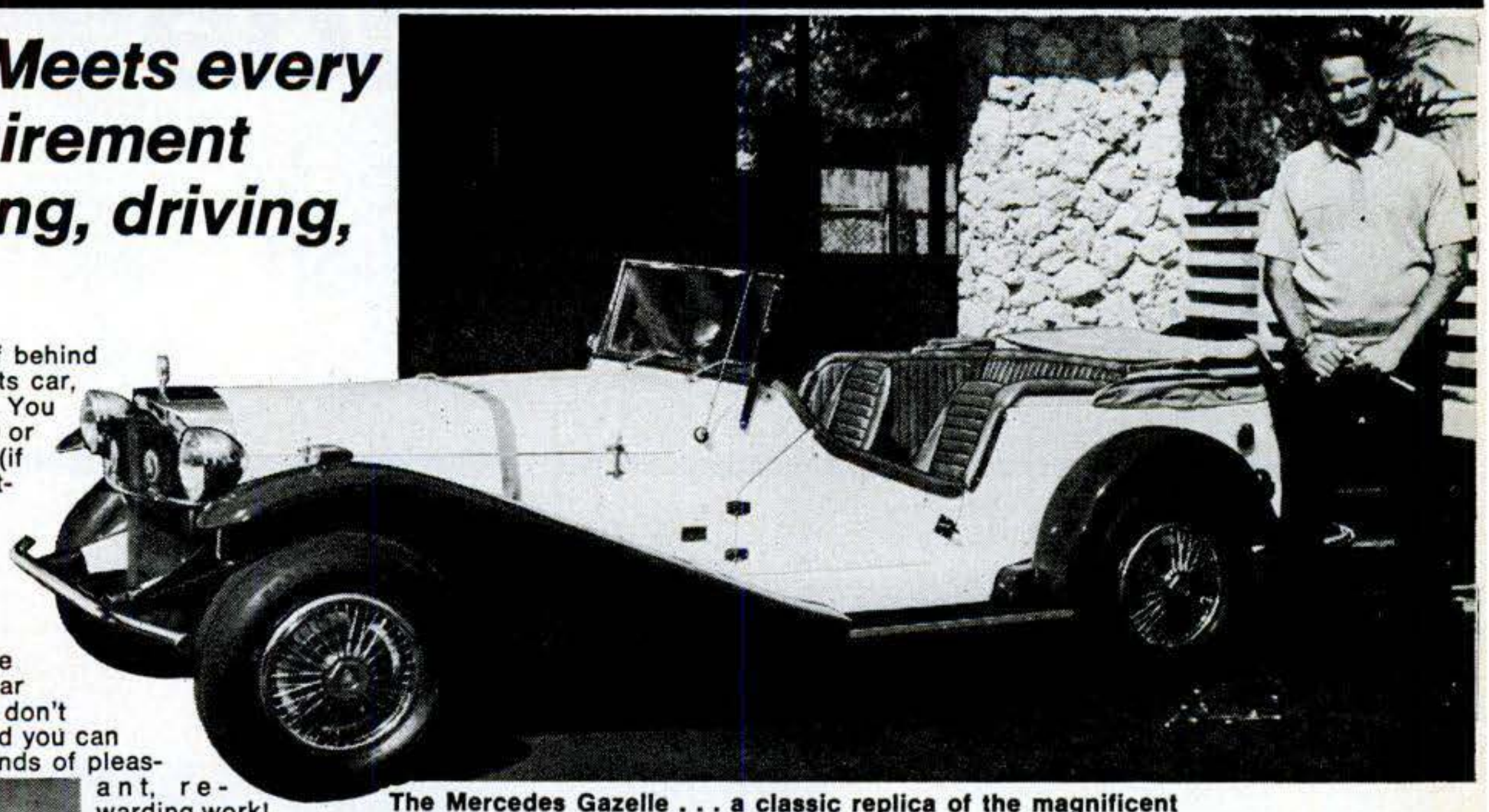

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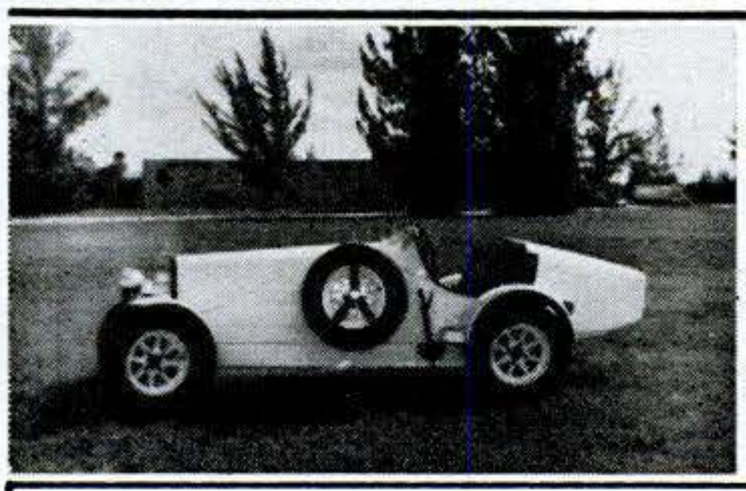

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Insulation upgrade

–plug those leaks your builder left

Here's a job you're likely to do better than the pros. You save energy dollars by insulating their skips

By AL LEES

A word of warning: If memories of last winter's chill drafts and even more chilling fuel bills have you thinking about adding insulation before the predicted repeat of a long, cold one upcoming—buy your fiberglass *now*. Sales went crazy early this year, and though all three major insulation manufacturers have enlarged their production facilities, they're only keeping up with current demand. There's little or no stockpiling, so if you delay until the first few cold snaps, you may find bare shelves at your nearby home center.

And insulating remains as practical a DIY job as any home improvement you might tackle. It's always been my contention that the homeowner will probably do a better job of upgrading than a pro installer. Indeed, your work may be superior to that of the original con-

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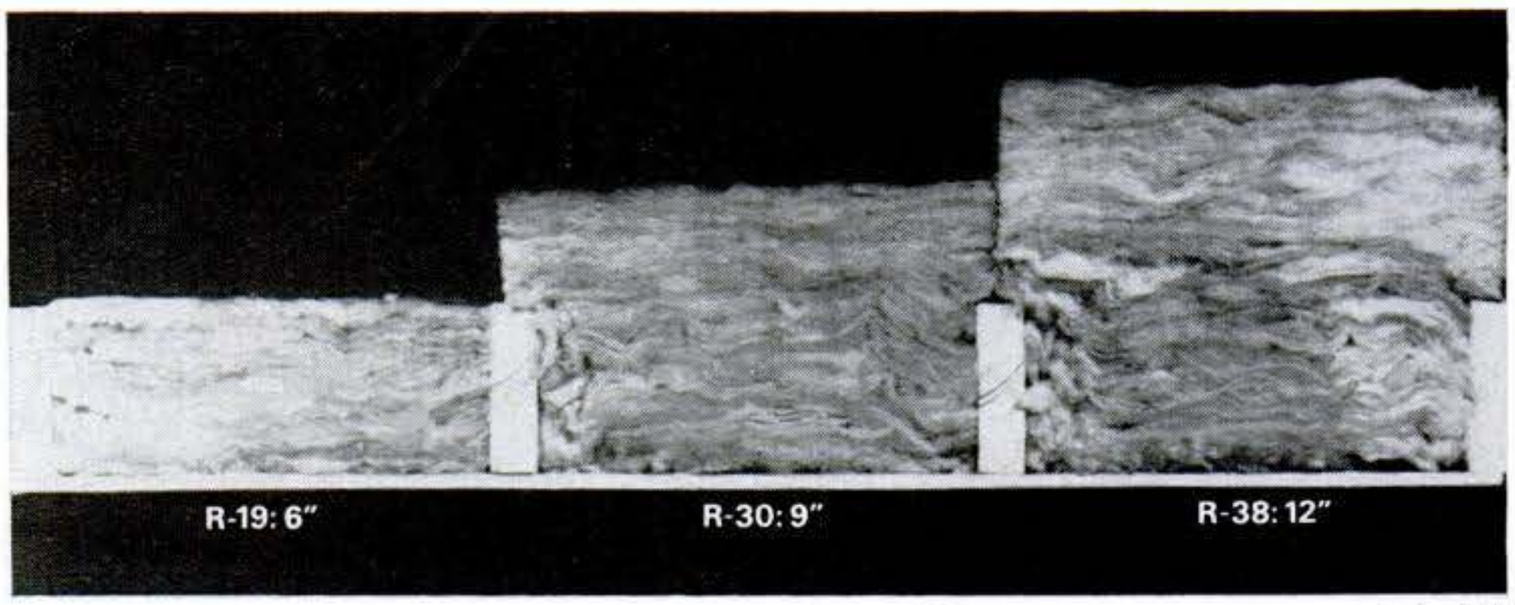
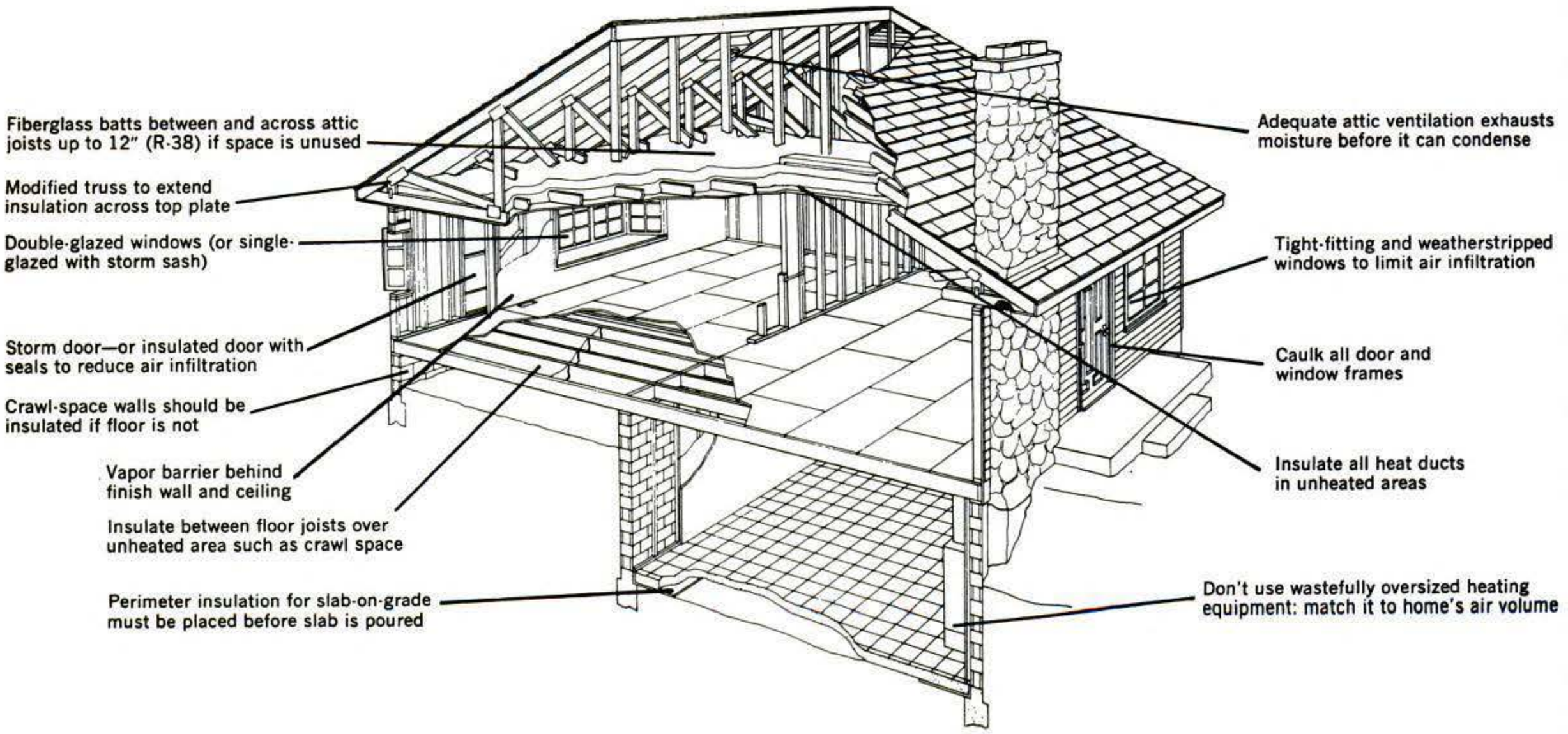


New insulations make upgrade easier. For attics with none, you can now pick 9" or 12" batts that are cut to full 16" (or 24") width so they'll lap joists.



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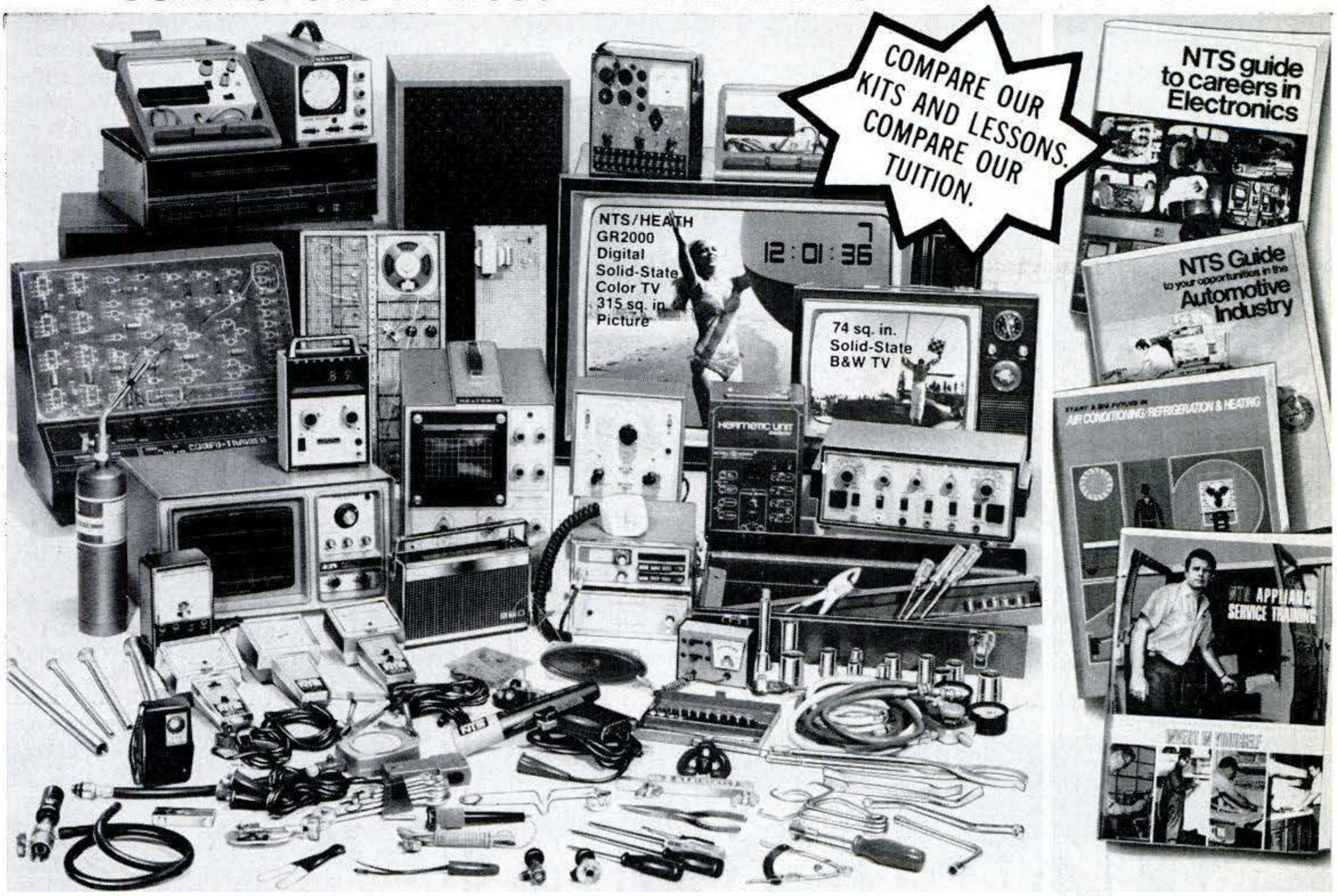

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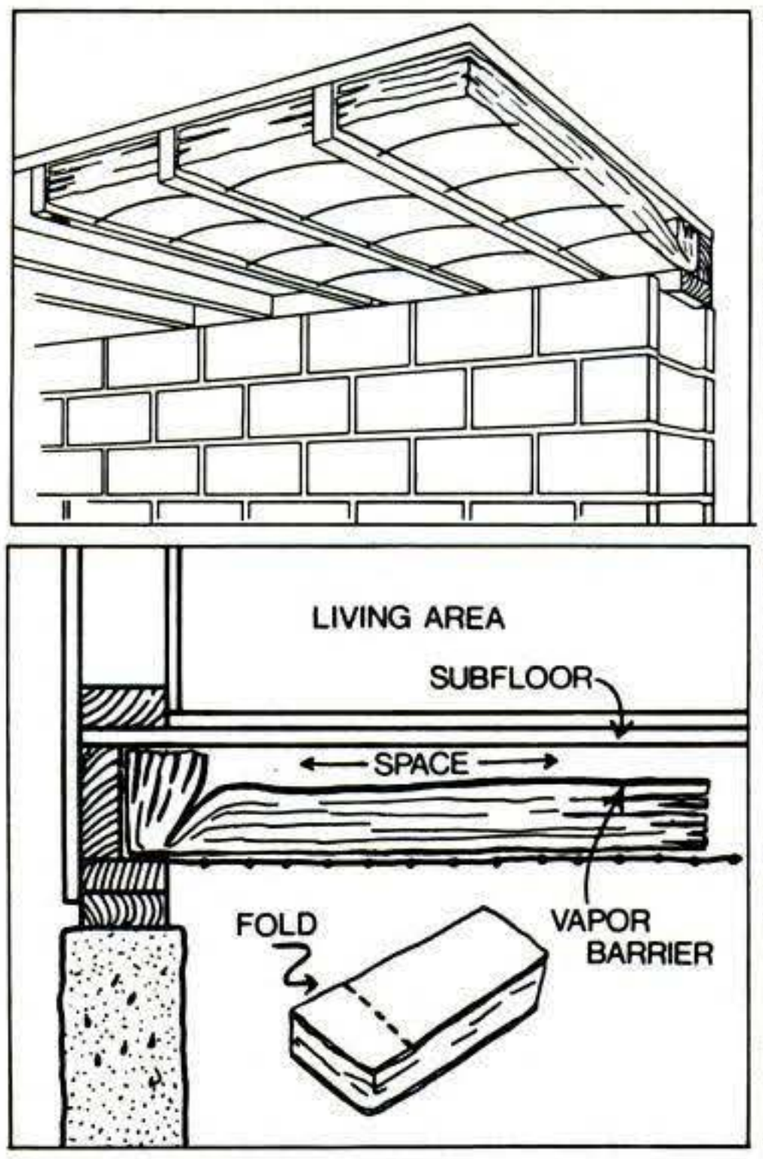

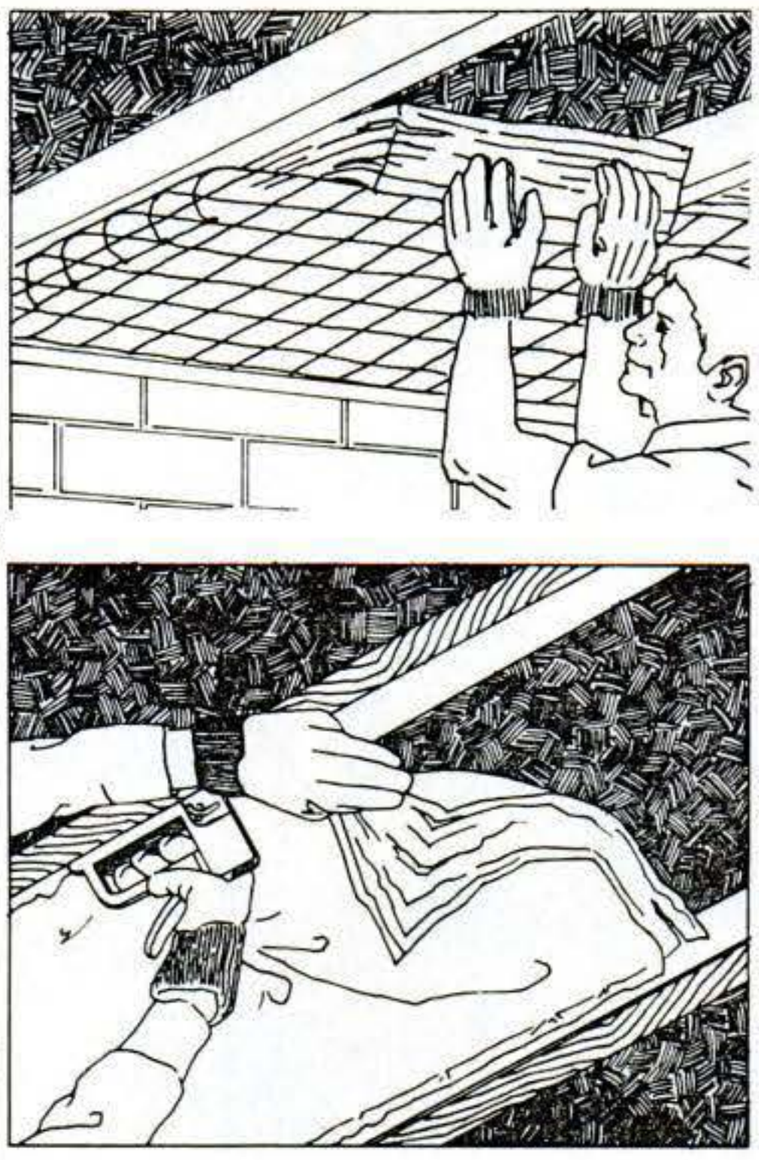

Under floors

For floors over unheated areas, batts can be supported in several ways (clockwise from top left): with special wires, pointed at both ends, bowed between the joists; with wire mesh (or chicken wire) stapled across joists; with special reverse-flange batts that have a permeable face for stapling. Headers should be insulated, too (lower left): Bend batts up to cover. Note that vapor barrier (if any) must always face warm side.

struction crew—assuming your home was built recently enough to have had insulation called for in the plans.

Very few homes are insulated as well as they could be. A small builder (putting up a few scattered houses) is likely to have his carpenters install the insulation, and they're often no more expert at it than you are. Worse, they lack the patience and concern you'll bring to the job. They must work fast and move on.

A large builder, on the other hand, will subcontract the insulating; nearly 25 percent of new homes are insulated by professionals. But their work will be only as good as the builder specifies. They've bid on what he asked for, and they're not likely to throw in more because they feel the house needs it. Either way, the builder is prone to overlook important areas, and those are the places you can profitably upgrade.

Most of these places are pointed out on the opening-page sketch, which we've adapted from Owens-

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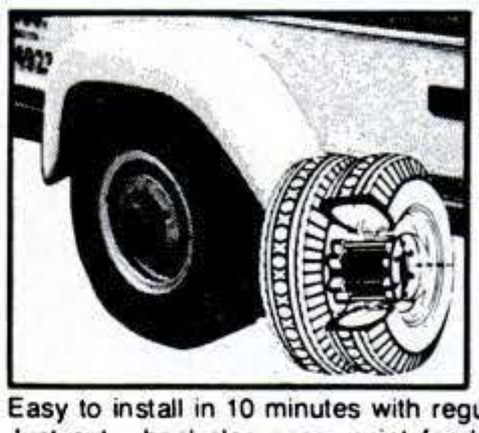

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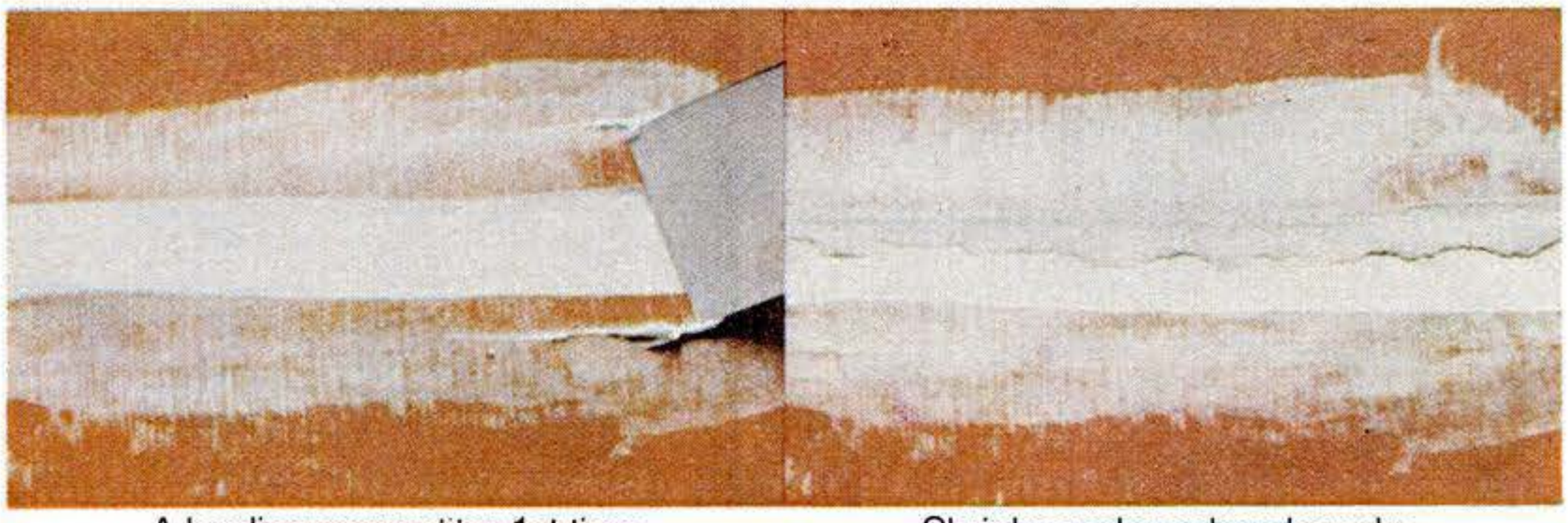

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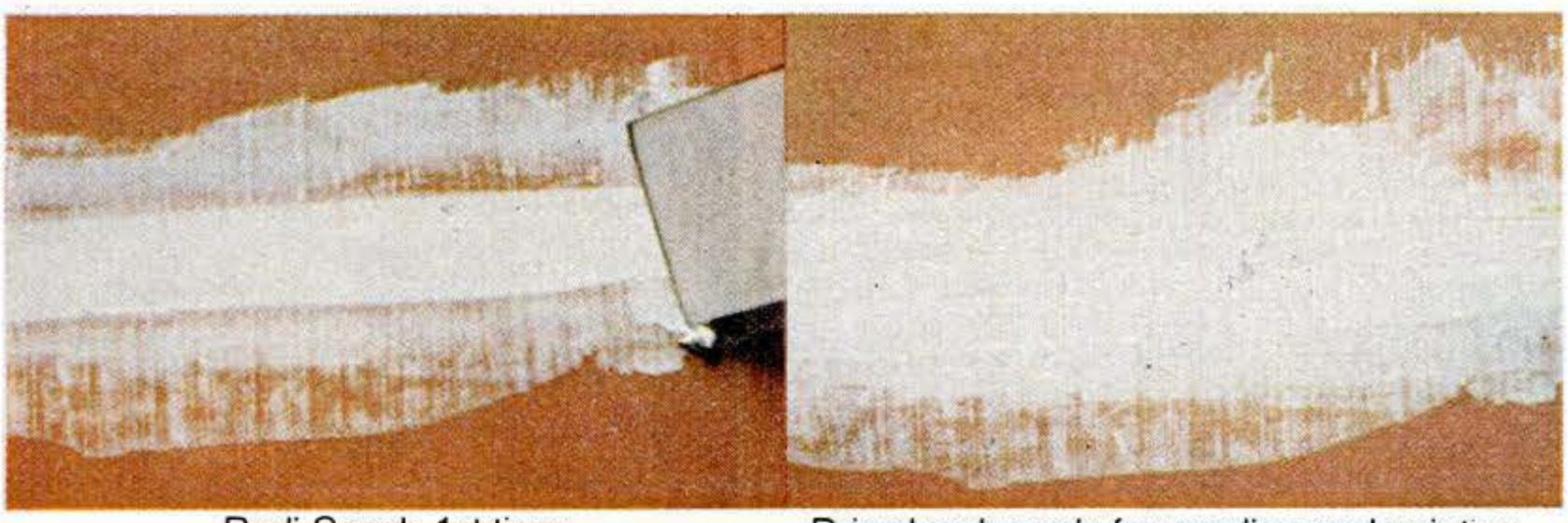

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Corning's analysis of the Energy Efficient Home (featured in its new national program for home builders). This "EEH" is, in turn, a modification of the Arkansas Project houses I've told you about [PS, Sept. '76].

Homes built to such specifications should never need a DIY upgrade. But this kind of builder concern for energy-saving is quite new.

The obvious place to start your upgrade is the attic; it's also easiest to check. If there isn't insulation up to the top of your joists, you probably don't have enough. The manufacturers make it ever easier to add more, by packaging new retrofit types (see photo; product information is at end of article). We deal only with fiberglass batts, here, since that's the insulation homeowners can readily install.

The thing to remember is that when you roll out new fiberglass over whatever's there, you want the *unfaced* type. Never float a vapor barrier *between* insulation layers.

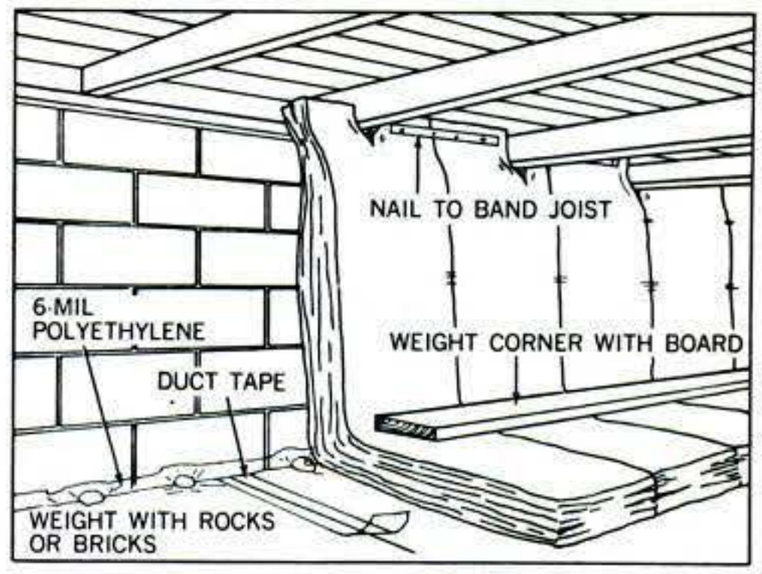
Other inadequately treated or oft-overlooked areas are shown in thumbnail sketches (courtesy CertainTeed Home Institute). Here are additional comments on these upgrades, in the same order the sketches appear:

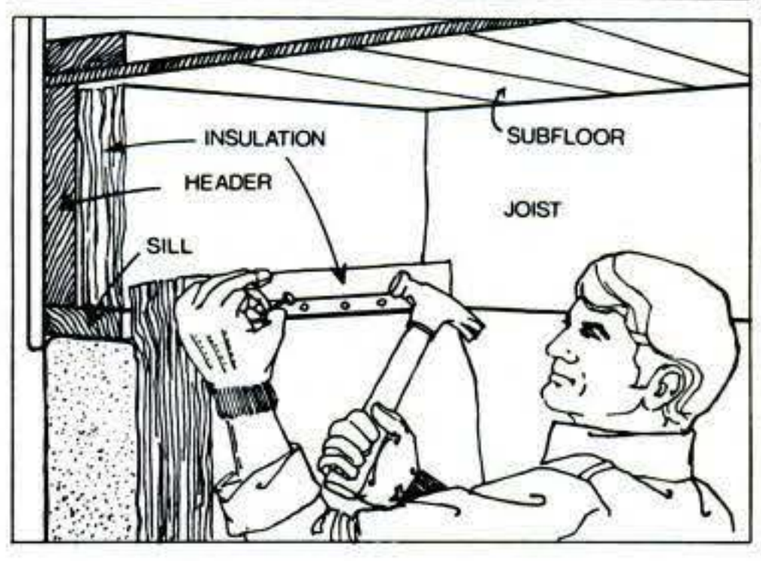
• *Under floors.* Since heat rises, you lose more through a poorly insulated roof than through a floor. But floors over an unheated crawl space, basement, or attached garage need insulation for *two* reasons: Heat will be conducted downward through an uninsulated floor. And it's equally important to keep winter air from touching the underside of your floors. Cold floors cause you to turn up thermostats even when the room's air temperature is comfortable.

The main difference in applying fiberglass to the underside of a floor is that when you put the vapor barrier facing toward the warm side (as you always must, whenever you are insulating) you "bury" the stapling flanges. So you must find an alternate means of securing the batts.

Of the techniques shown, I find

Continued





Crawl-space walls

It's best to insulate foundation walls instead of floors. Run fiberglass up to floor —either by slitting (top) or by cutting strips to press-fit between joists, against header. Tack batt to sill edge.

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Insulation upgrade

[Continued]

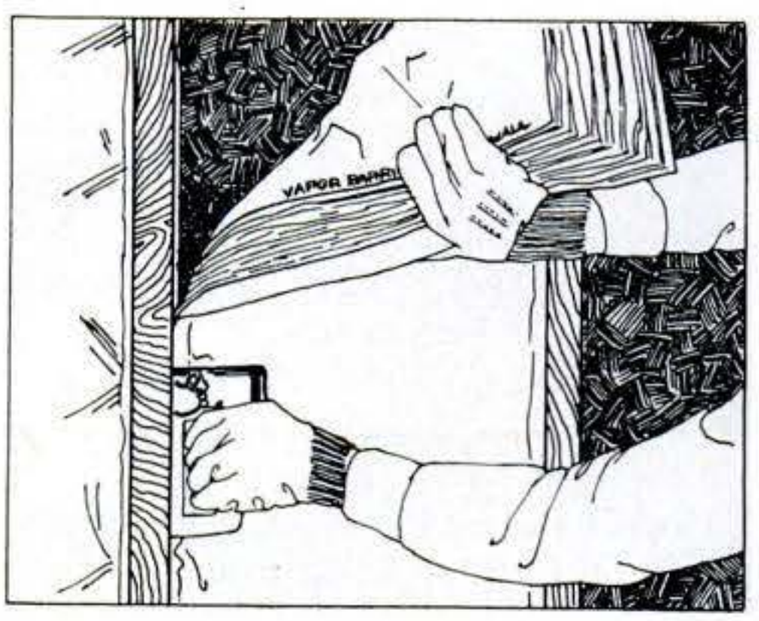
the pointed wires most convenient. You can buy them from Easton Wholesale Co., Box 500, Easton, Md., or Tiger Teeth, Inc., Box 8314, Charlotte, N.C. 28209. Be sure to specify your joist spacing (usually 15″ or 23″) so they'll send the proper length.

After you've installed insulation

[Continued on page 173]

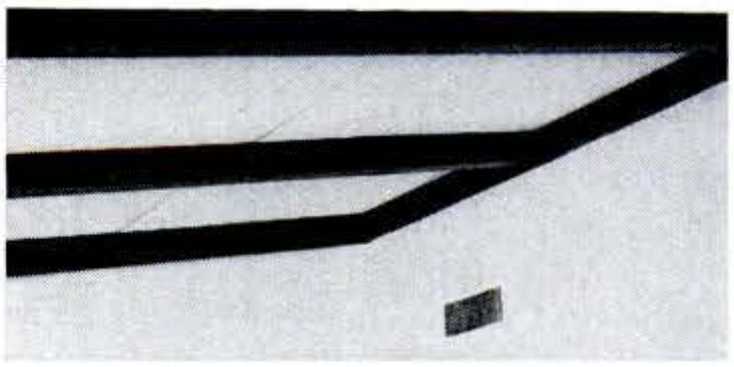
Exposed ducts

Heating ducts that pass through cold areas should be insulated. Though standard batts can be secured with duct tape, special duct wrap (2″ min.) is best.



Back of wall

Working from outside in—as when insulating an open-backed partition between house and unheated garage—calls for reverse-flange batts (see text).



Cathedral ceilings

These popular exposed-rafter ceilings are energy wasters—unless the builder installed an insulating deck under the shingles. To insulate such 20-year-old homes at Dyess Air Force Base, 3″ thermal ceiling panels from Owens-Corning were cut to fit between rafters, glued to underside of roof, as in photo above.

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HOUSEPOWER CLINIC

By EVAN POWELL

Water-heater timer

My answer to a letter in May's Housepower prompted a flurry of requests for more details on water-heater timers. Here's what I've found. These devices are designed to turn electric water heaters on for a few hours a day—normally just before you use the hot water. They are basically heavy-duty timers that hook up to the circuit powering the water heater. (But some timers I've seen are not as heavy as they should be.) A few timers are plug-in types, but most are wired directly into the line, so installation is usually a job for a pro. Prices (including installation) range from $50 to $80.

Many timers come with a guarantee that they will reduce your water-heating bill. The explanation included with some implies that they save power by shutting down the water heater at night, eliminating overnight heat loss.

Actually, no water heater is ever constantly on—it heats water to the preset temperature, then is turned off by the thermostat. Using a timer to shut off the heater at night saves you nothing. It takes the same amount of power to reheat the water, whether it's done just prior to use or the night before.

With a timer installed, hot water is available only during a certain period of the day. Unless you're very consistent about when you use hot water (most homeowners aren't), the device is likely to allow water to reheat *after* your demand period. This negates its only potential for energy savings. Or, if the timer sets a heating period that's too short, you may run out of hot water in the midst of a wash or bath.

In my own testing I found that many common water heaters don't cycle on during long periods of nonuse, anyway—there just isn't that much heat loss through the insulation. Those that do cycle stay on for only about 15 minutes. Eliminating *that* heat cycle yields a savings of about one cent per day; this shoves the payback point for a timer so far into the future that installation makes no practical sense.

What about the money-back guarantee, and the fact that you can easily find homeowners who vouch for the timers' money-saving capabilities? What's happening here is similar to what goes on when you buy one of those "miracle" gadgets to reduce a car's fuel consumption. Once you've installed the device, you become much more diligent about conservation: It's your use-habits that change. But we're still testing.

Manual defrosting, part II

Comments about our April story, "Manual Defrost Switch Can Save Energy," range from variations offered by other readers to letters from appliance-industry officials pointing out (as we did in the text) the pitfalls of this modification.

Both sides have a point. We published the story because numerous readers asked if it was possible to reduce the cost of operating frost-free units. We noted that, using this switch, you have to inspect evaporator coils several times daily to make sure there's no frost buildup. But, as industry spokesmen pointed out, the coils on most refrigerator-freezer units are concealed behind a panel. To get at them you have to unload the food compartment and then remove several screws. And the panel can't be left off, since it's part of the air passageway. Also, the defrost switch must be located where it won't break the vapor seal of

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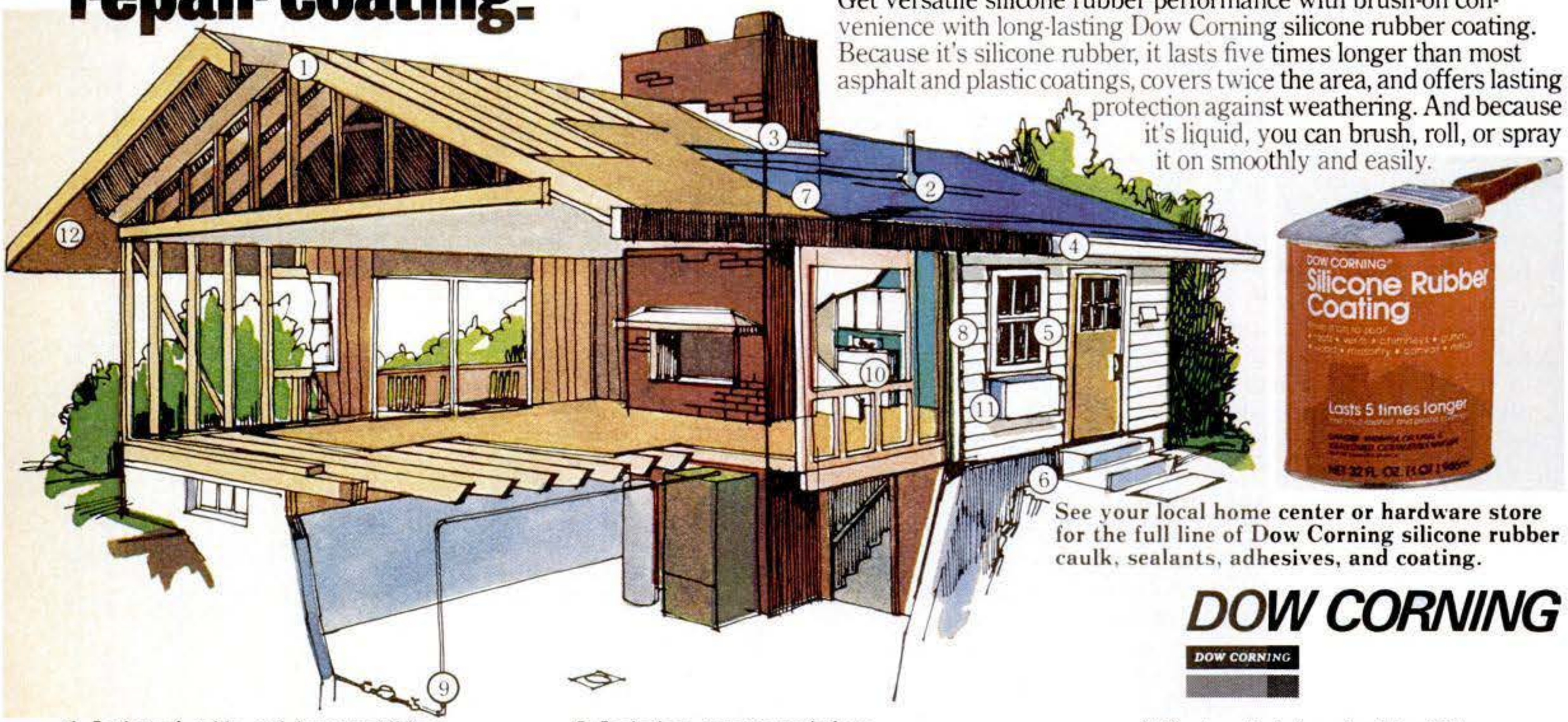

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the refrigerator cabinet; an industry spokesman pointed out that this wiring modification voids the UL safety listing.

Final verdict: Though a manual defrost switch might improve the existing time-temperature control system slightly, it's not worth the risks.

Door in a door

Whirlpool's new Serva-Door feature is intended for convenience, but it's also an energy saver. The special area, designed to store the items you use most, is completely isolated, so it minimizes cold-air losses from the main unit. Through-the-door ice and water dispensers also reduce door openings. Now I would like to see such ideas combined with double-foam-insulated cabinets to give us some super-high-efficiency refrigerators.

If you're thinking of buying a new refrigerator, it's worth the effort to obtain a copy of AHAM's new directory of certified refrigerators and freezers (50 cents from the Assn. of Home Appliance Mfrs., 20 N. Wacker Dr., Chicago, Ill. 60606). Shelf area and capacity ratings have been simplified, and the energy consumption of practically every available refrigerator is listed in kilowatt-hours per month. Though actual usage in homes varies considerably, these "closed-door" figures do provide a reasonable comparison of models to help you decide.

Q&A "Bagpipe" plumbing protection

No answer required, but we thought you'd like to know how we make sure water is absent from each branch of the supply lines in an unheated home.

Turn off the water and drain the pipes as much as possible. Then cut a small hole in the corner of a large plastic garbage bag. Tape this over a faucet mouth and inflate the bag the way you'd blow up a paper bag you're going to burst. Close the mouth of the bag with your hands, then squeeze it between your elbow and body until the pipe is clear. Two points to remember: Start at the top of your house and work down; and don't forget to fill all drain traps with an appropriate concentration of anti-freeze solution.

Leonard M. Steinberg, Potomac, Md.
Renato R. Carazzai, Princeton, N.J.

Thanks for the tip! In checking it out, I find that it's a great way to winterize RV's, too.

Cold Hotpoint dryer

My Hotpoint clothes dryer still runs perfectly after 11 years, but suddenly it won't heat. I have tested the element, door switch, and all connecting wiring. Any suggestions?

William Weaver, St. Augustine, Fla.

I have a hunch that you may have been deceived by the fact that the dryer can still run. Insufficient power may actually be the problem. If one *side of the 115/230-volt line is open, only 115 volts are available. This lets motor, lights, and timer operate normally, but there's no voltage available to complete the 230-volt heating circuit. Replace the fuses or flip the circuit breaker and you may be happily surprised at the results. Don't rely on a visual inspection of the fuse; it won't likely show that it's blown. And*

Continued

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[*Continued*]

even a double-pole (connected) circuit breaker can kick out on one side.

If this isn't the answer, have a motor shop check out the centrifugal switch in the motor. In a dryer, this switch does double duty—it starts the motor and is a safety switch for the heater.

Reversed water-heater connections

My American Appliance water heater has three connections on the top marked "hot," "cold," and "relief." Recently, I noticed that the supply is connected at "hot" and the outlet connects to "cold." Can an incorrect hookup have detrimental effects?

Pete Servaas, Tucson, Ariz.

It sure can—it can reduce your available hot-water supply to almost nothing! Such careless installations occur far too often. On tanks with top fittings, the cold-water inlet has a dip tube installed inside the threaded nipple to carry the incoming cold water to the bottom of the tank. The hot connection simply opens into the hottest portion of the tank at the very top. Reversing the connections dumps the cold water into the top of the tank and takes the hot water from the bottom. Since hot water rises, that doesn't work very well.

But if you have plenty of hot water, don't jump up to unsolder those lines. The plumber who installed the heater may have removed the dip tube and reinserted it in the "hot" fitting. But if you're not getting enough hot water, you now know why. In any case, be sure that a combination pressure-temperature relief valve is installed in that opening marked "relief."

Refrigerator venting

Has anyone given serious consideration to providing manual or thermostatically controlled switches on dishwashers and refrigerators so that the units can be vented into the house in winter and outdoors in summer?

I have always felt that one of the greatest shortcomings in design was a house with a frost-free refrigerator and an air conditioner. In the summer we buy electricity to run a refrigerator which, as a byproduct, puts warm, moist air into the house. We then use more electricity to run an air conditioner to remove heat and moisture from the house. The result is that we buy electricity for competing effects. And to make matters worse, as the temperature rises, we normally make greater use of the refrigerator for ice and cold beverages, which causes the refrigerator to run more, which causes the air conditioning to run. Is there no way out of this system?

James R. Carter, Knoxville, Tenn.

Getting rid of appliance heat is also a vicious circle. A ventilation system adds to the cost, while other necessary components, such as larger forced-air fans, add to energy consumption. The question is whether or not the unwanted heat is sufficient to warrant the expense of removing it. Appliance-heat recovery (and the related problem of heat removal) is the subject of several current studies. We're following them closely and will have a future report.

In the meantime, many householders would do well to implement previous PS suggestions regarding appliance-heat input. Since most heat-producing equipment is concentrated in the kitchen, close off dampers and air-conditioning supply lines to that room. Close interior doors, open windows, and use natural ventilation (or an oversize range fan) to keep the area reasonably cool. In the winter, heating supply lines can also be kept closed since the refrigerator, range, and dishwasher produce enough heat to keep most kitchens comfortable in all but the coldest weather.

Got a problem?

Looking for an answer to your home-equipment problems? Write Evan Powell, Housepower, 108 Morningdale Drive, Greenville, S.C. 29609, giving make and model number of equipment. Sorry, but questions can't be answered by mail.

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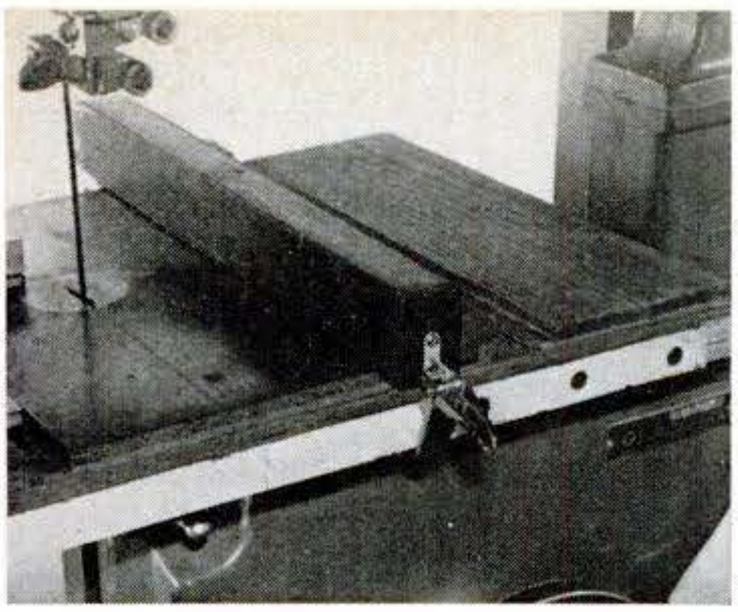
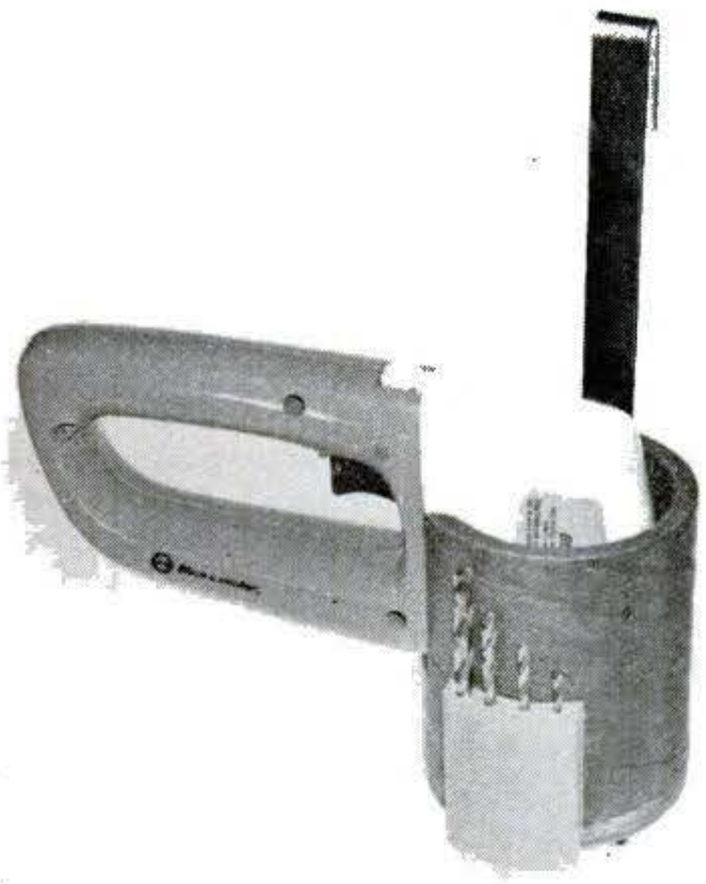


Fence fastener

Want to take the end play out of fences on your band or table saw? Try a draw-pull catch, like those used on suitcases—you can get one at your hardware store. Be sure the catch you choose won't protrude beyond the side of the fence. Screw the base of the catch to the rear of the fence; attach a metal or plywood strip along the back edge of the table as a slide for the catch. (Most tables have a couple of tapped holes at the back.) Now, just hook the catch over the slide. It will glide smoothly along as you adjust the fence. When you're ready to lock the fence in place, just flip up the catch.—*W. Waggoner*

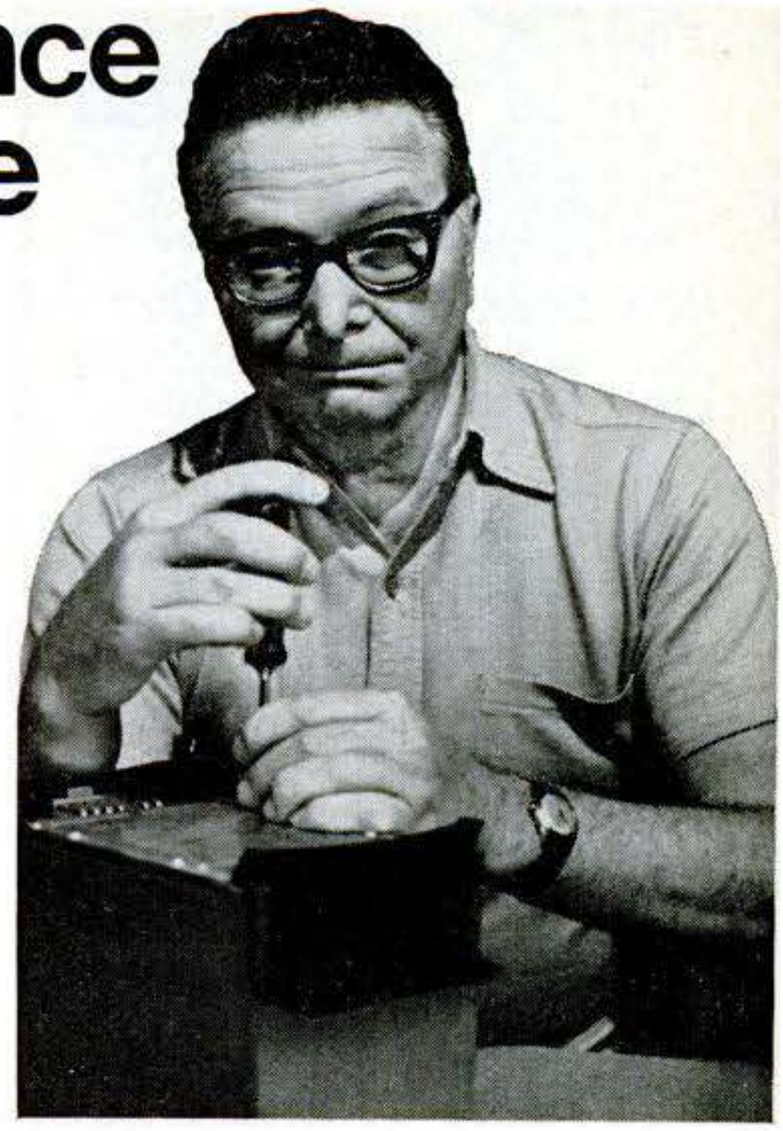


Drill holster

A heavy cardboard tube makes a useful belt holster for your cordless electric drill. Cut a slot in the cardboard wide enough for the drill handle and deep enough so the chuck protrudes through the bottom hole. The cut-out, glued to the tube's side, makes a handy drill-bit carrier. The vise-formed belt loop, a ¾" aluminum flat riveted to the holster, can also be stored on a nail.—*W. Waggoner*

HENRY MORGAN SAYS:

"Good appliance repairmen are scarcer than doctors who make house calls."



Did you know that there are over a billion appliances in use in the United States today? And three repairmen. At least that's the way it seems when one of mine goes on the blink. With more than two dozen electrical gadgets in my house going snap, crackle and pop, I finally got tired of trying to locate a guy with enough ambition to take my money and I decided to learn how to make the repairs myself.

When a well-aged comic like me decides to go back to school, you can bet the family jewels it won't be back at P.S. 93. I'm going to learn at home, or not at all. So I sent away for NRI's home study course in Appliance Repair . . . and I took the course.

With a mechanical aptitude slightly below that of King Kong, I needed a course that started at the beginning and didn't move ahead too fast. Well, NRI did just that. They started with electricity—what it is and what it does—and went from there. You proceed at your own rate of speed. Whip through it if you want to, or take your time. What counts is the fact that you learn, in a way that it sticks with you.

You learn two things: how to repair appliances—from little one cylinder gas engines to refrigeration and air conditioning equipment; and how to get started in your own appliance business. That can mean money for you either way. If NRI can turn old ten thumbs Morgan into a reasonable facsimile of a repairman, think what they could do for you!

NRI's no fly-by-night outfit. They've been training men for more than sixty years . . . and they've had over a million students. It's the oldest and largest home study school in the field of electronics and electricity, so they know it better than anyone else around.

The NRI course is really easy to understand . . . with lots of pictures to show you what they're talking about. They even send you a professional appliance tester at no extra cost.

With the tester and a few basic tools you probably have already, you're ready to service most electrical appliances. After a few months, you'll be fixing your own appliances like I do, or you can start earning spare time money fixing them for your friends and neighbors. Before you know it, you can have your own full-time business and be independent.

Take my advice and clip the coupon. Even if you don't know which end of a screwdriver is the handle, they can give you real professional training that'll help you break into the appliance repair field. It's one of the few things I've ever sent for that was even better than they said it would be . . . so why not invest a postage stamp to see if it's right for you. The NRI catalog is free and there's no obligation. No one will knock at your door or bug you at home. NRI doesn't use salesmen. They don't need them.

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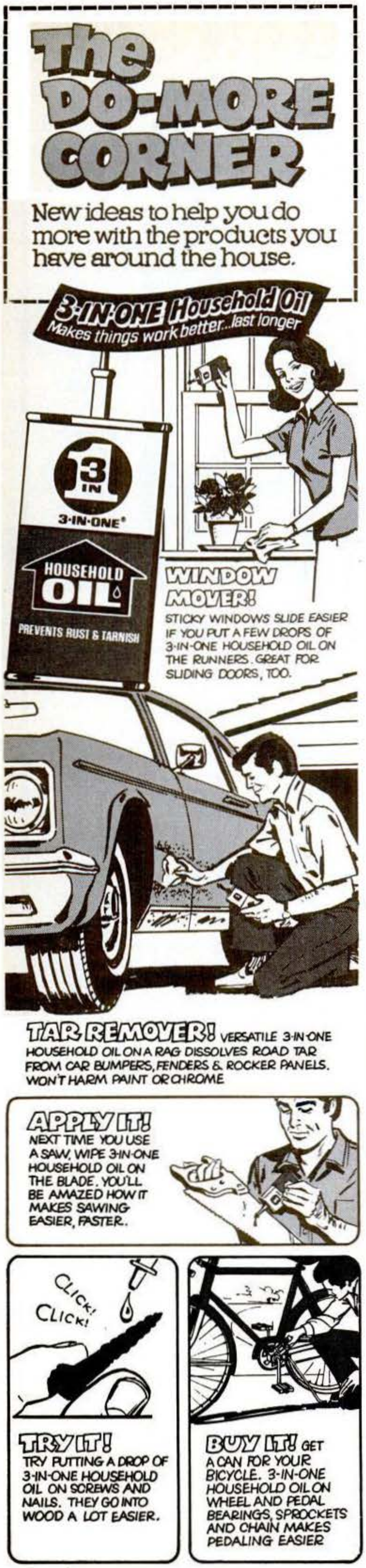

SHOP TALK

By RICHARD STEPLER

Sunshine goes swimming

The story describing PS art editor Dave Houser's solar swimming-pool heating system ["Dual-Use Solar Wall," Apr. '77] concluded with this sentence: "This spring Dave and Rita (his wife) hope to be in the swim by early May." Were they?

"Because of unusually cold and cloudy weather," reports Dave (he's shown with his solar wall in the photo above), "we didn't take off the pool cover until Monday, May 16. Water temperature at startup was 60°. Definitely too chilly for swimming.

"By Sunday, the 22nd, we were swimming in a pool filled with 83° water."

Weather conditions during the six-day period: daytime air temperatures ranging up to 85°; nighttime lows in the 50's. Five days were mostly sunny, and one day was cloudy and overcast.

But what about the price?

We've had some queries from readers on the quoted price of the Fafco solar pool-heating system. Dave paid $90 per four-by-eight-foot plastic collector, for a total installed cost of $1271.50, including controls.

Since Dave installed his system (summer of 1976), there have been price increases in Fafco's products: A four-by-eight-foot collector now costs $115, and average installed cost nationwide for a typical system, according to Fafco, runs about $2000. But the sunshine still costs the same.

You can get more information on Fafco's solar pool-heating system by writing the company at 138 Jefferson Dr., Menlo Park, Calif. 94025.

Quilted window shade

The insulated window shade shown in the drawing below should dramatically reduce heat loss through your home's windows. Rainbow Energy Works—the people who designed it—say that you'll recover the shade's cost in eight years if you heat with gas. If you heat with electricity, payback comes in four years.

One of the nicer features about the shade is that it's inexpensive—$1 to $1.50 per square foot of window area to be covered. And you can build it yourself, using plywood and stock lumber for the housing and side tracks (the latter hold the shade close to the window to provide an effective seal). The shade itself is a sewn, quilted sandwich: two layers of your choice of fabric and ¾" to 1½" polyester batting.

Send $2.50 to Rainbow Energy Works (3765 17th Street, #B, San Francisco, Calif. 94114) for plans to build the insulating window shade.

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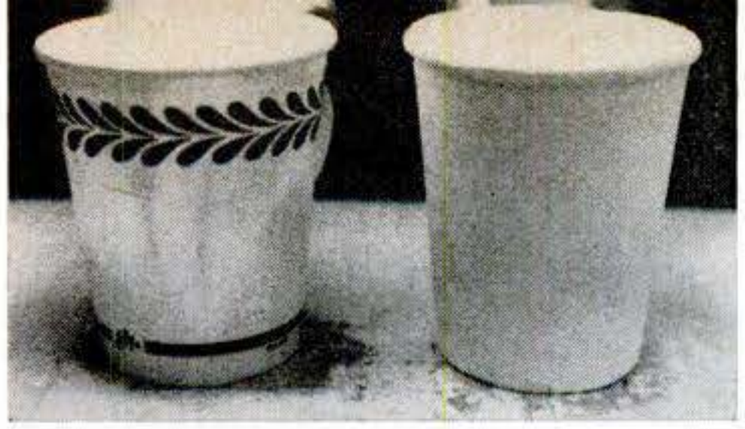
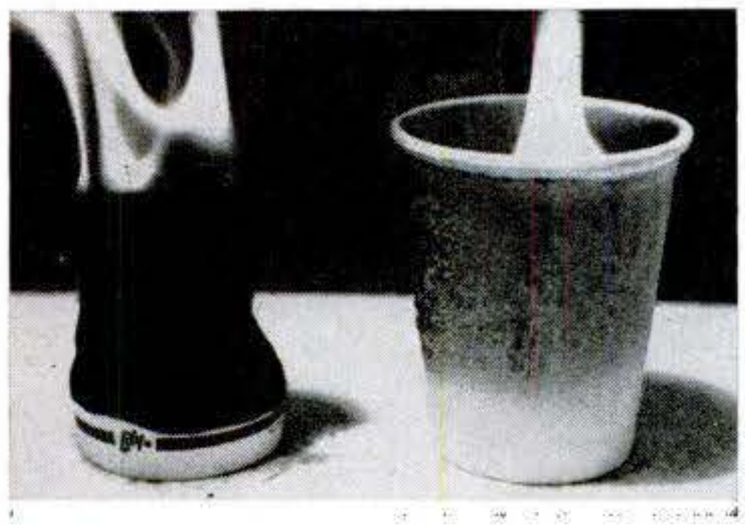




Blazing Dixies

Wadded paper tissue was set ablaze in these two paper cups to prove that the one on the right—which is coated inside and out with Fuller-O'Brien's Blox-Blaze paint—wouldn't burn. As the photos show, it didn't.

Reason? When Blox-Blaze is exposed to flame or heat it intumesces—forms a thick, charred layer that provides no additional fuel for the fire and insulates combustible material underneath.

The flame-retardant paint, listed by Underwriter's Labs, is a good choice for stairway and bedroom doors or the walls of a furnace room. Fuller-O'Brien recommends a two-coat application (200 sq. ft. per gallon).

Blox-Blaze, which costs $17.50 per gallon, is available in a wide range of colors—from Fire White to Burnt Sugar.

Things to write for

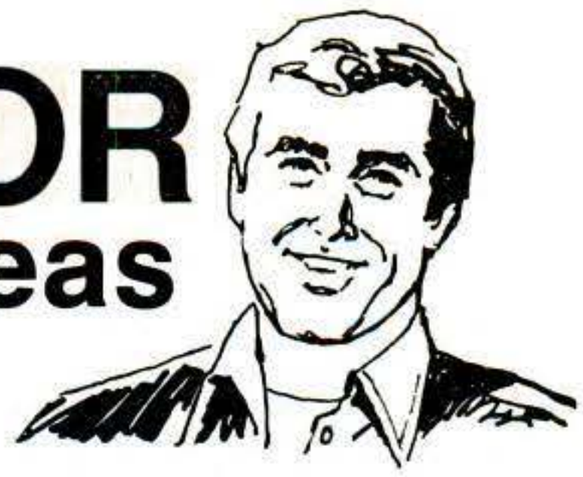
● *Environmental Products Catalog.* Wind-powered attic vents, weather stripping, wood stoves, and solar-heating components—they're all in a 34-page catalog, free from J. C. Young Co., 5621 E. Calle del Paisano, Phoenix, Ariz. 85018.

● *Sun-Angle Charts.* Where's the sun at 2 p.m. today? Bennett Sun-Angle Charts show you for any time of day and any time of year at a designated latitude. They're available for north latitudes from 24° to 52° in increments of 2°. Send $2.50 for each to Robert Thomas Bennett, 6 Snowden Rd., Bala Cynwyd, Pa. 19004.

● *Save Energy, Save Dollars.* This 100-page manual for consumers covers all aspects of home heating and cooling, the selection and use of appliances, water heating, new construction and remodeling, and transportation. Special sections cover energy conservation in apartments and mobile homes. It's $1.50 from the Mailing Room, 7 Research Park, Cornell University, Ithaca, N.Y. 14853.

● *Solar-Energy Bulletin.* Filon (12333 S. Van Ness Ave., Hawthorne, Calif. 90250) offers a 10-page technical bulletin on the performance of the company's fiberglass sheets when used as glazing for solar collectors. PS

ANCHOR your ideas with



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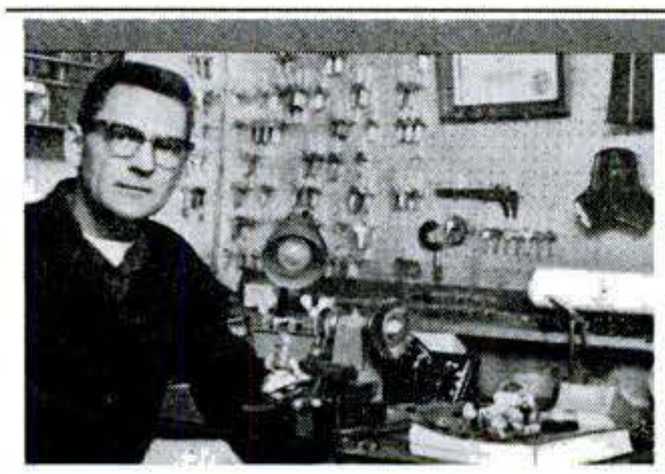

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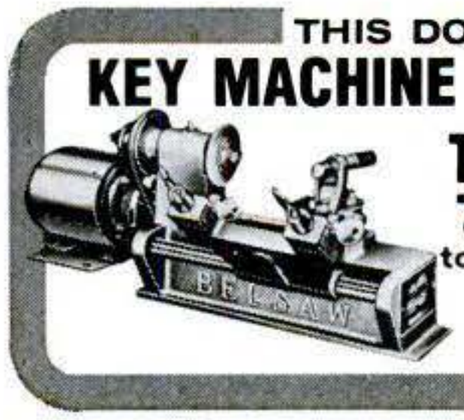

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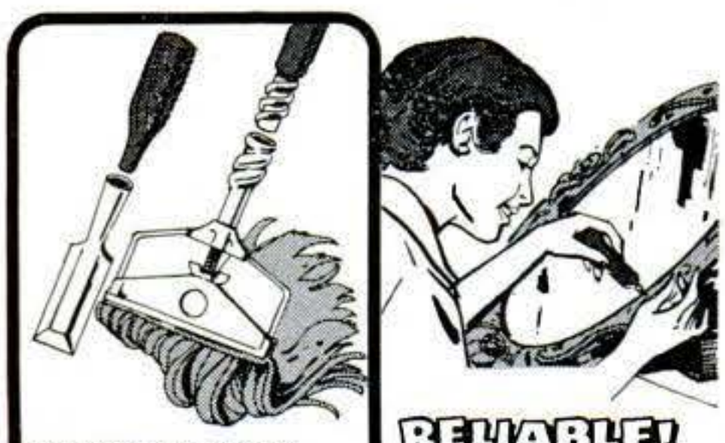

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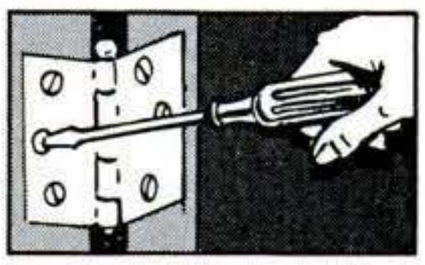

TAKING CARE OF YOUR CAR

By RICH CEPPOS

Got a useful car tip? Send it (with Social Security No.) to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you $25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.

Connecting brake lines

When installing or reconnecting brake lines or hoses, be sure to tighten them securely, rather than snugging them up as you would a spark plug. If they are not tight, air can seep back through them into the system, causing problems like a spongy pedal, or as serious as loss of brake power. Use a tubing wrench (shown) to tighten all flare fittings in the brake system. It slips over the brake lines like an open-end wrench but is less prone to rounding off the edges of the connecting nuts. This technique should ensure trouble-free operation.

Installing shocks

If your car is designed to have the front shock absorbers installed through the engine compartment, from above, there's an easy way to prevent the rubber grommet on the bottom end of the shock from sliding off when you lower it into position. Push a lead pencil point between it and the lower stud, then break off the point. This will hold the grommet in place but won't interfere with proper operation of the shock absorber.

Removing stripped nuts

Is a stripped thread keeping you from removing a nut from a screw or bolt? Try this: Screw another identical nut down on top of the offending nut. If the bolt or screw is free to spin, be sure to secure it from behind. Then clamp the two nuts together with a pair of locking pliers and unscrew the two nuts; they should come off together. Discard the screw or bolt and that first nut to avoid any repeat of the problem.

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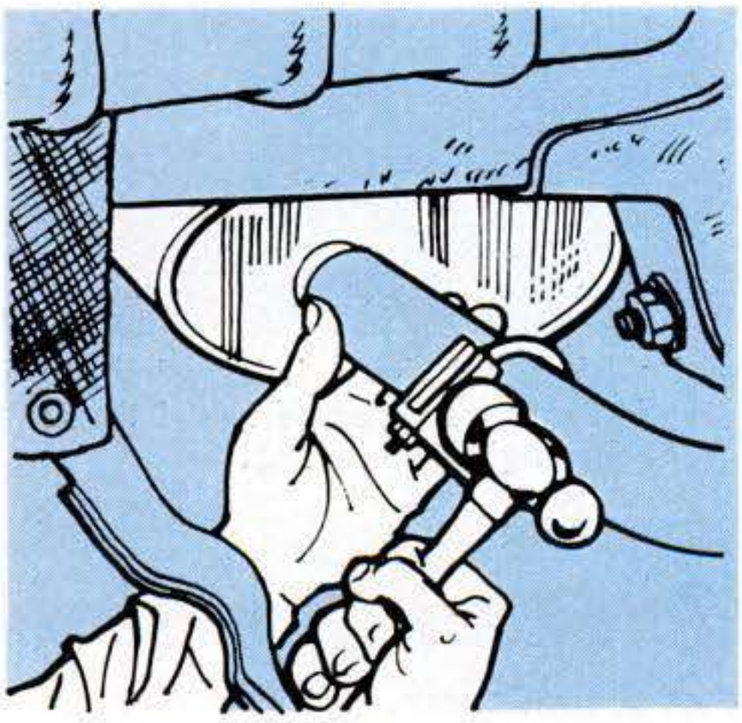
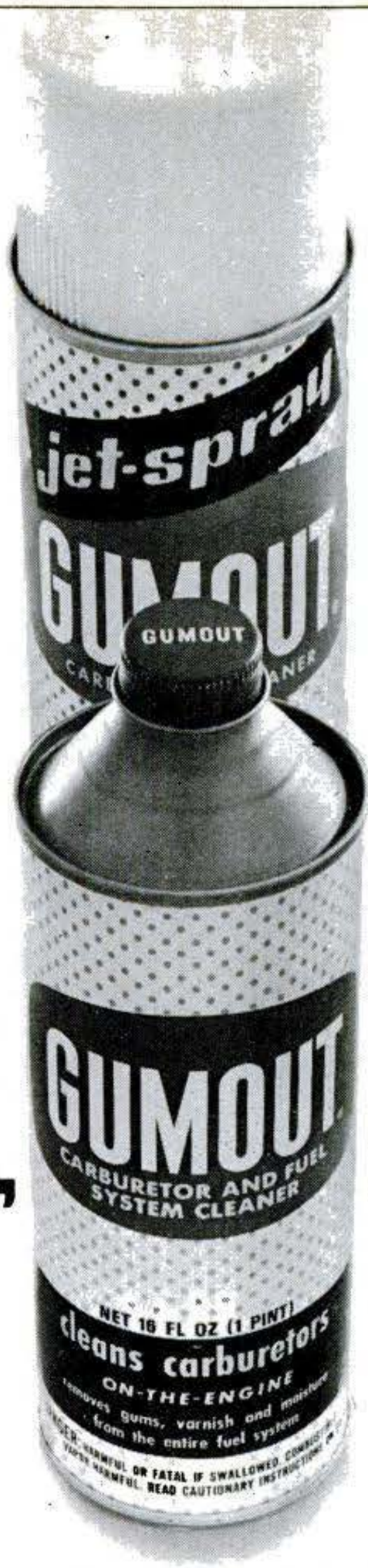
Fixing fuel leaks

If you're bothered by a persistent leak at a flared fitting in your car's metal fuel line, try twisting a ring of thin copper tubing around the fuel line, as shown. The ring will increase the pressure on the connection and seal the leak, preventing loss of fuel.



Installing a tail pipe

If you find that slipping a new tail pipe into a muffler outlet requires more muscle than you can muster, place a muffler clamp about four or five inches from the end of the tailpipe. Hang the tail pipe in position temporarily with wire coat hangers. Maneuver it up to the muffler outlet and drive it in by hitting the muffler clamp with a hammer. The projecting end of the pipe should seat right up to the clamp.



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AUTO-MAINTENANCE BASICS

18th of a series

How to use a dwell tach

By RAY HILL

Dwell angle, as the pros call it, is important to your engine's performance. It's the number of degrees the distributor cam rotates while the ignition points remain closed. Correct dwell permits full electrical energy to build up in the ignition coil for a strong spark at all engine speeds.

Too little dwell (points not closed long enough), and the spark is too weak. That results in poor acceleration, misfiring at higher rpm, and decreased gas mileage. Too much dwell (points closed too long), and the points burn and wear out rapidly.

Dwell should be adjusted at every tune-up, of course. But for best results it should be checked periodically between tune-ups—say every 2000 miles or so. That's because the rubbing-block on the arm of the moving point wears, which

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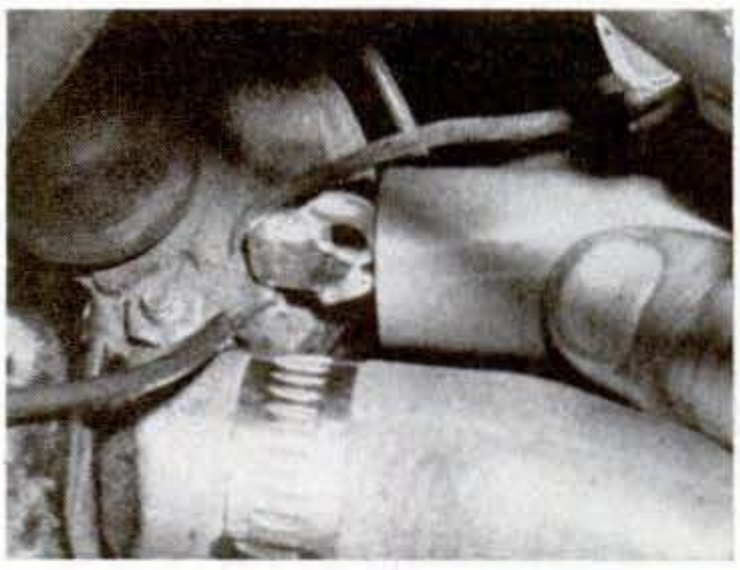
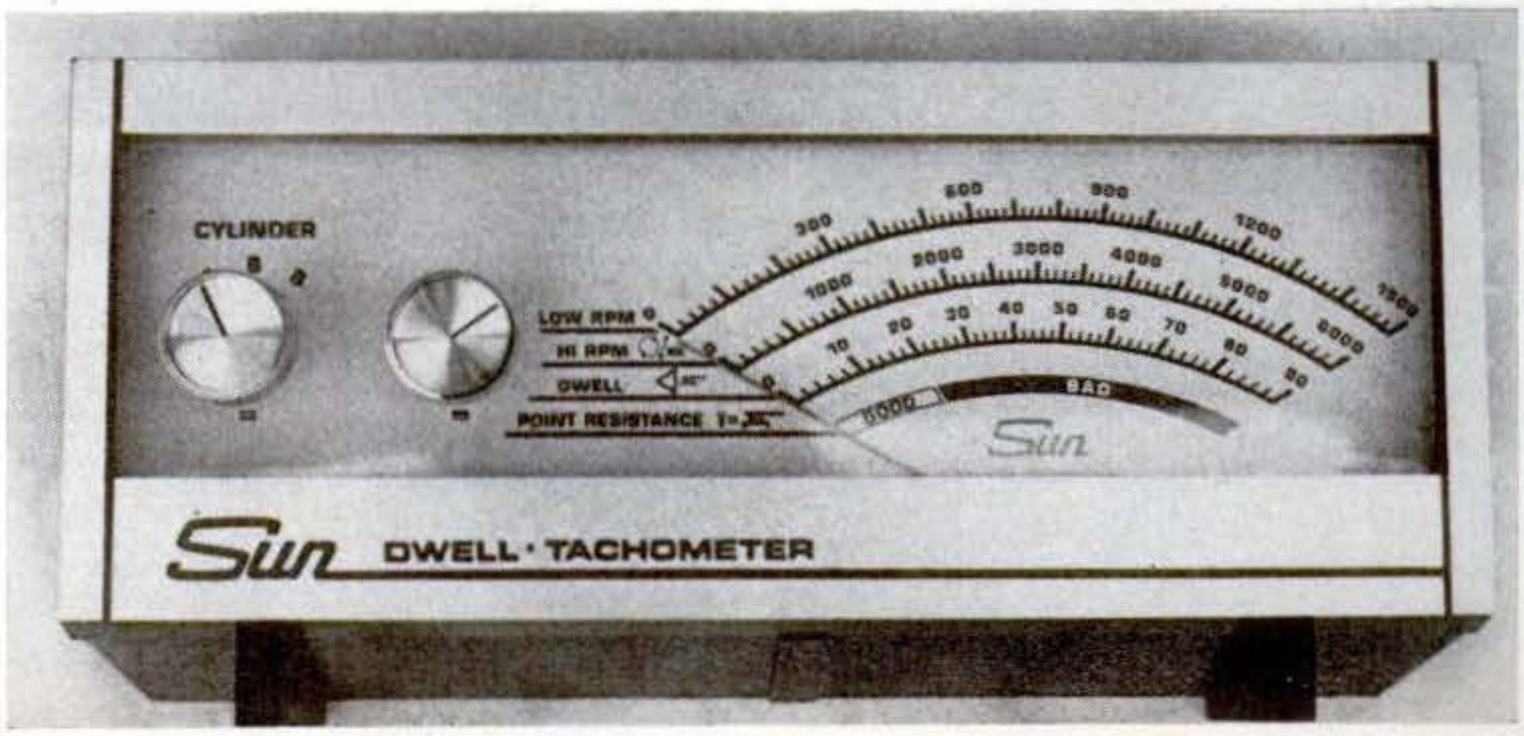


To hook up most dwell tachs, attach the lead with the red boot to the negative terminal of the ignition coil.

Lead with black boot is attached to ground—any bare piece of metal that's part of the engine works fine.



After electrical hookup, meter is set. This one is set to show rpm between 0 and 1500 on four-cylinder engine.

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The earth has a clock all her own when she does things or doesn't. And one of the things she does is make grass grow differently in the fall than it does in the spring. No kidding. Your lawn gets thicker in the fall.

A little Turf Builder in early fall and your grass will grow sideways.

In the spring, everything reaches up for the sun and grass blades do too. They grow up and up. But with the warm days and cool nights of fall, this upward growth is slower and your grass actually grows more sideways and starts new grass growing beside itself. It does this by sending out tillers and rhizomes and these send down new grass roots. You couldn't pick a better time to put down some fertilizer.

So if you spend just a half an hour with a spreader and some Scotts® Turf Builder,® what you will get for it is a darker thicker lawn that doesn't take as much mowing as it did in the spring. And that isn't all you get for your half hour's work. You also get a knitting of new roots to take the worst of winter, along with a storage of carbohydrates down in the ground that will get your turf started earlier than most other lawns next spring.

We make Turf Builder so that it lets its nitrogen out a little at a time to keep on feeding your roots for just about 8 weeks. (We have U.S. Patents on the way our Turf Builder is made.) And if you happen to have some weeds and dandelions you want to get rid of at the same time, we also have Turf Builder Plus 2.® This gives you a weed control with fertilizer mixed in with it. More grass and good-bye dandelions with one pass of your spreader.

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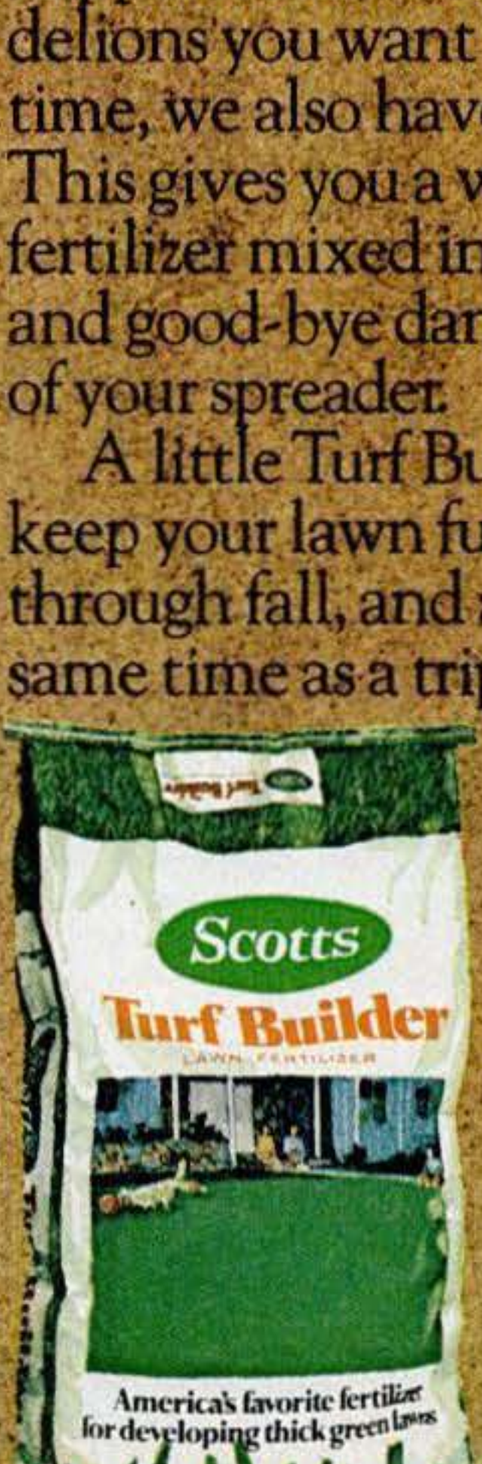

Dwell tach

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causes the dwell angle to change.

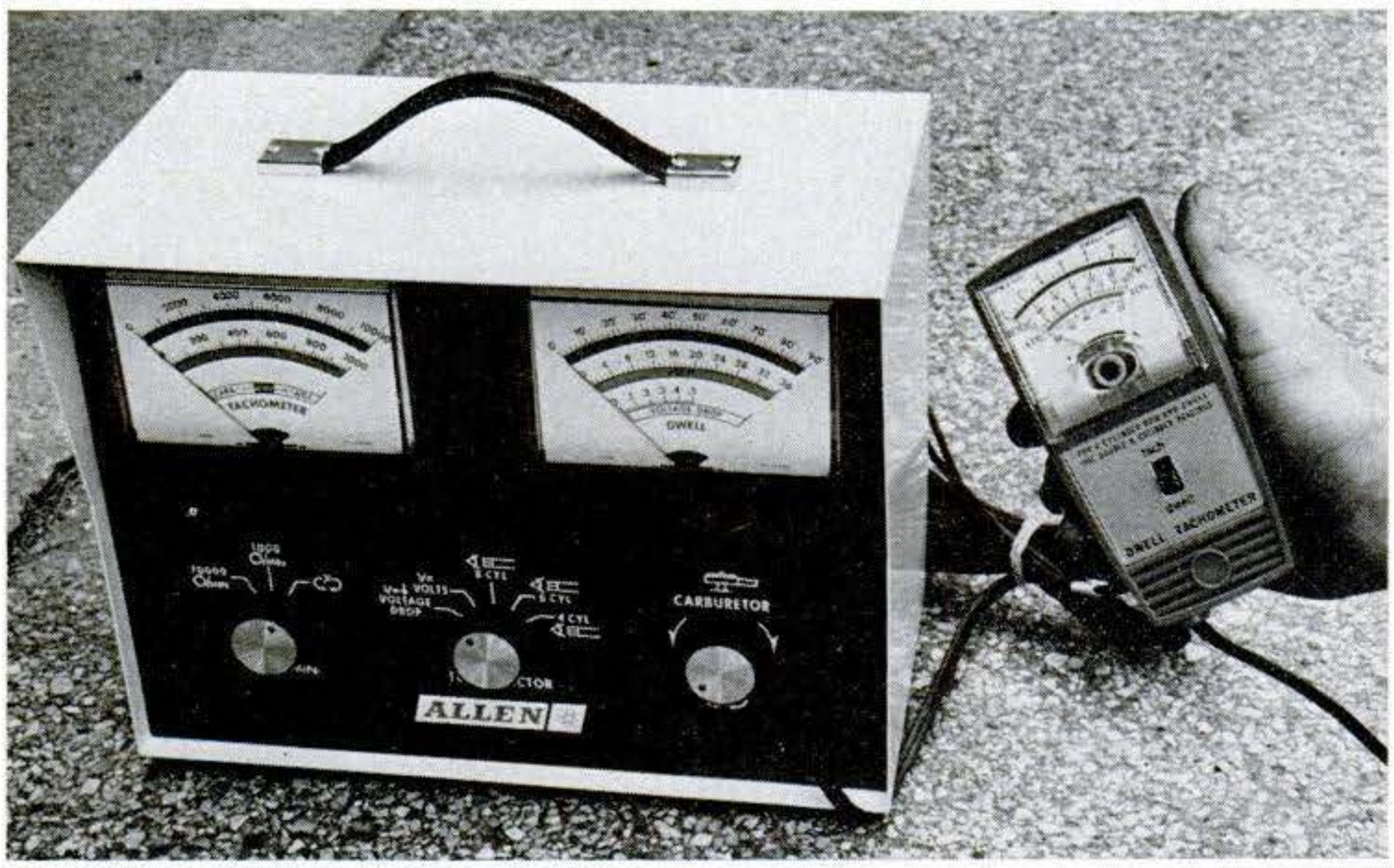
To check dwell quickly and accurately, you need a dwell-tachometer. Dwell-tachs range from less than $20 to over $100, but they all do the same thing—measure dwell and engine rpm.

Using a dwell tach is easy. Most come with two wires with an alligator clip at the end of each wire. One clip is covered with a black boot, the other with a red boot.

The lead with the red boot clips to the negative terminal on the ignition coil. That's the terminal for the small-diameter wire that runs from the distributor to the coil (not to be confused with the large-diameter high-tension lead that runs from the center of the coil to the center of the distributor cap).

The lead with the black boot is attached to a good ground—any piece of bare metal that's part of, or attached to, the engine.

Meter specifics vary, but generally they have two switches or knobs: One indicates the function (dwell or rpm); the other is a selector that corresponds to the car's number of cylinders (four, six, or eight). These switches are operated only after the unit is plugged in. Some meters, especially the cheaper ones, require owners of four-cylinder cars to read the eight-cylinder scale and then double that reading.



Sizes of dwell tachs range from small, inexpensive hand-held units to large units with large price tags. Bigger units generally have easier-to-read scales.

Checking dwell

When checking or adjusting points, check the specs in the shop manual for your make and model

Continued

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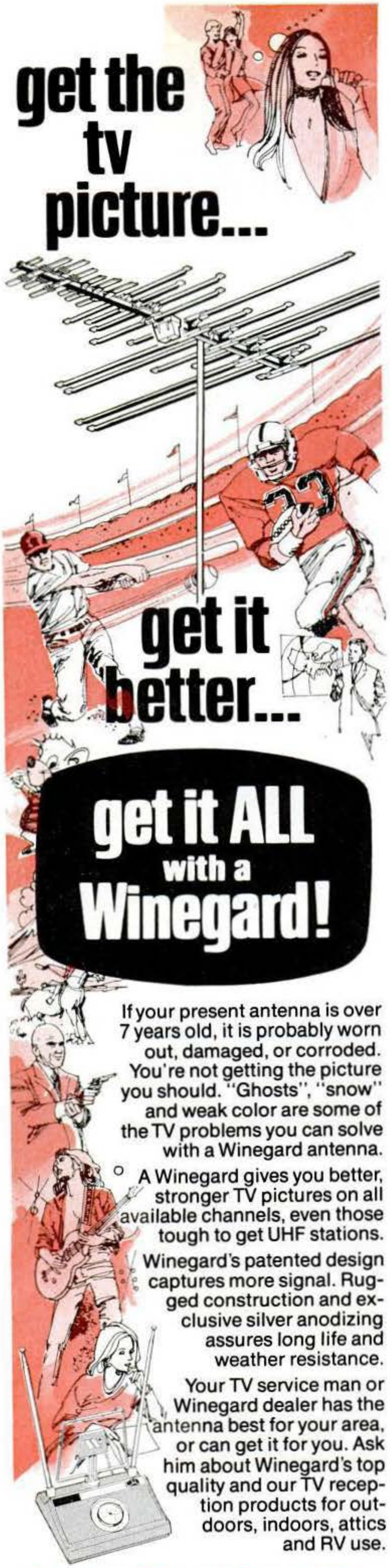

Dwell tach

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of car. Let's say specs call for 35° of dwell at 750 rpm. First thing you want to do is make sure your idle rpm is correct. Set your meter on the "tach" position and read engine rpm at idle (this should be done with the engine at operating temperature and the choke fully off).

If engine rpm is not 750, then adjust idle speed up or down in accordance with shop-manual instructions until the tachometer reads 750 rpm.

Now you're ready to check dwell. With the engine idling, set the meter to its dwell function. Read the dwell scale. If dwell is not 35, adjust the points until you get a reading of 35 (or whatever the specs on your car require).

Adjusting points on some cars doesn't require removing the distributor cap; on others, it must be removed. Check your shop manual. Widening the point gap decreases dwell time; narrowing the gap increases it.

Your dwell tach can also be used as a troubleshooting aid. Some things you can do with it are:

• *Dwell-variation check.* Rev your engine up to 1500-2000 rpm and watch the dwell meter as you do. Dwell should not change more than three degrees. If it does, it may mean a worn or bent distributor shaft, or worn bearings or bushings.

• *Power-balance test.* Pros with more complex engine testers can press a button and short out cylinders one by one, watching to see how much the rpm drop as each cylinder stops firing. The same thing can be done with a dwell tach.

With the engine running at idle or a little above, remove and reconnect each spark-plug wire. Record the rpm drop for each cylinder as its wire is disconnected. It should be approximately the same amount. If there is not a drop, or a very small one compared to the others, the cylinder should be checked for an ignition, compression, or fuel-system problem—because it's not producing as much power as the others.

To remove and replace the wires, use insulated pliers made for removing and replacing the boots at the ends of the plug wires.

On cars with catalytic converters, do not perform this test: Letting raw gas pass through the converter

Continued

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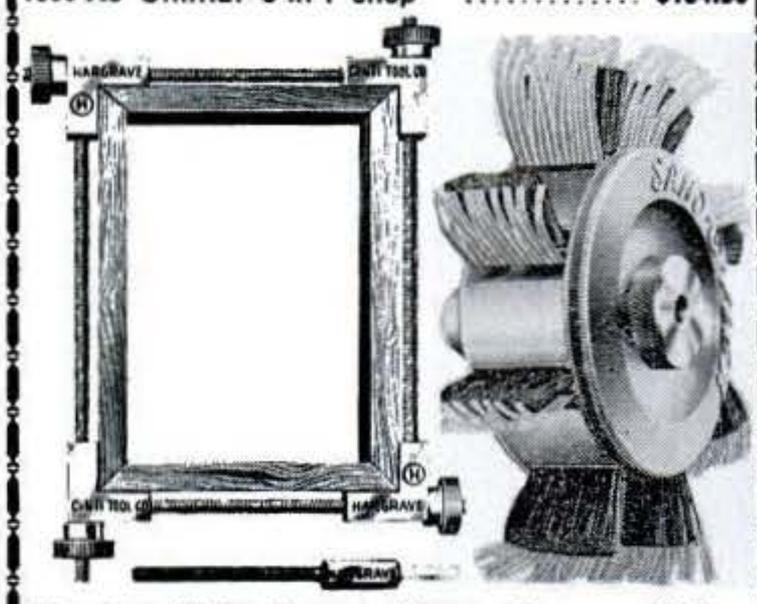

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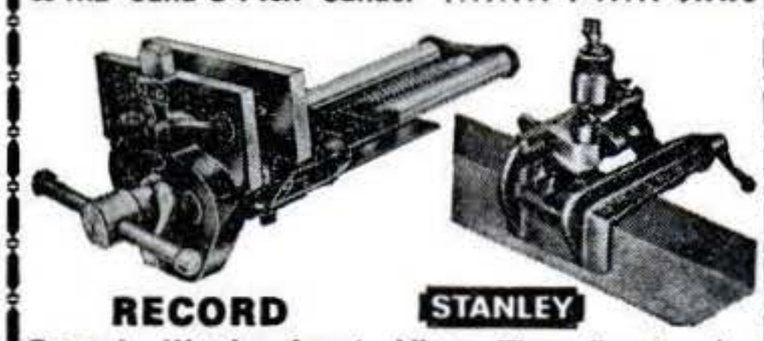
35-M2 Sand-O-Flex Sander **$17.98**



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52D-R10 7" Vise—22 lbs. **$34.50**
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4480(330)-R7 . ... **$47.98**

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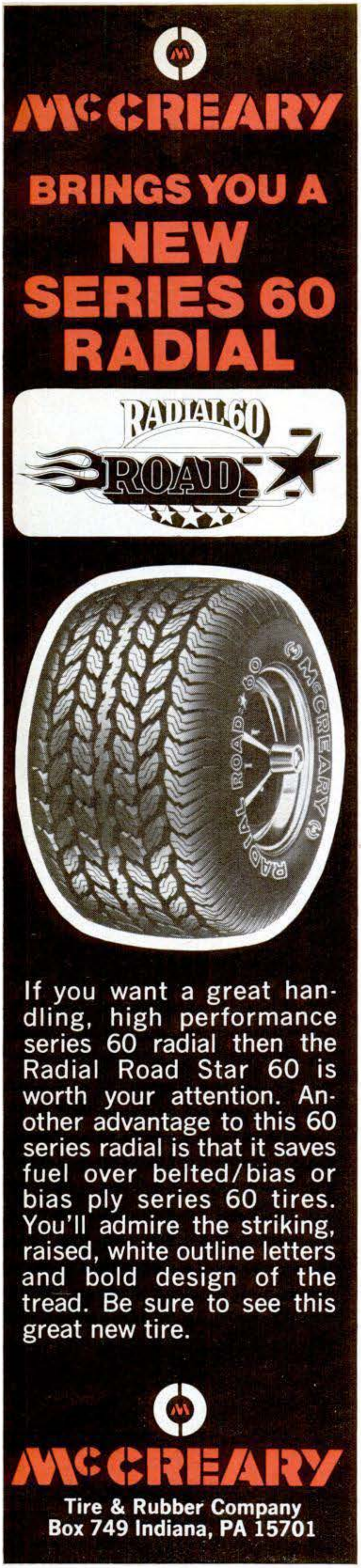
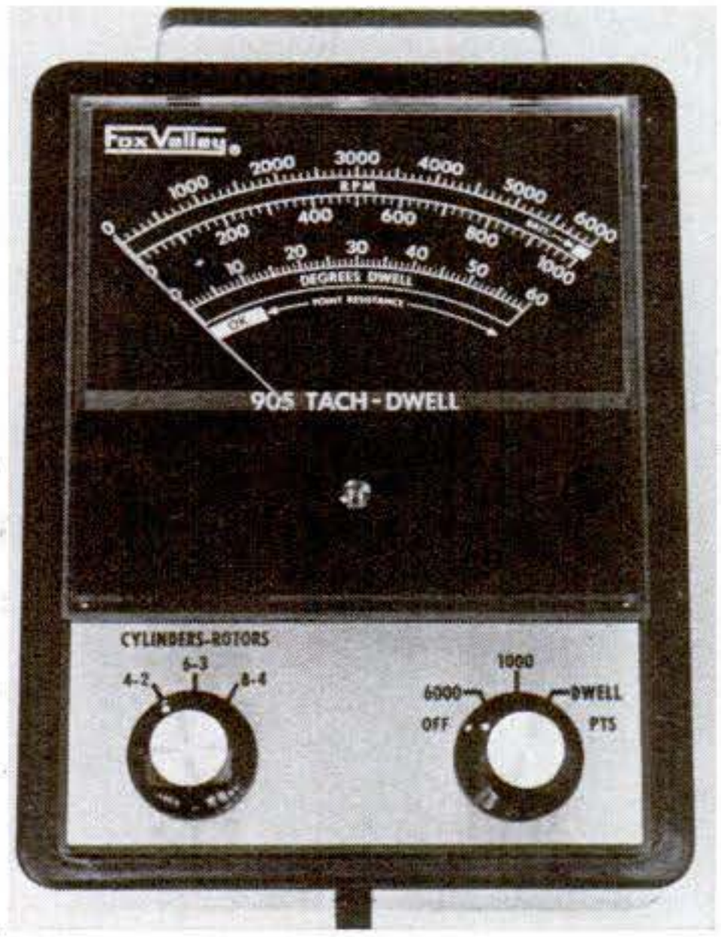


Dwell tach

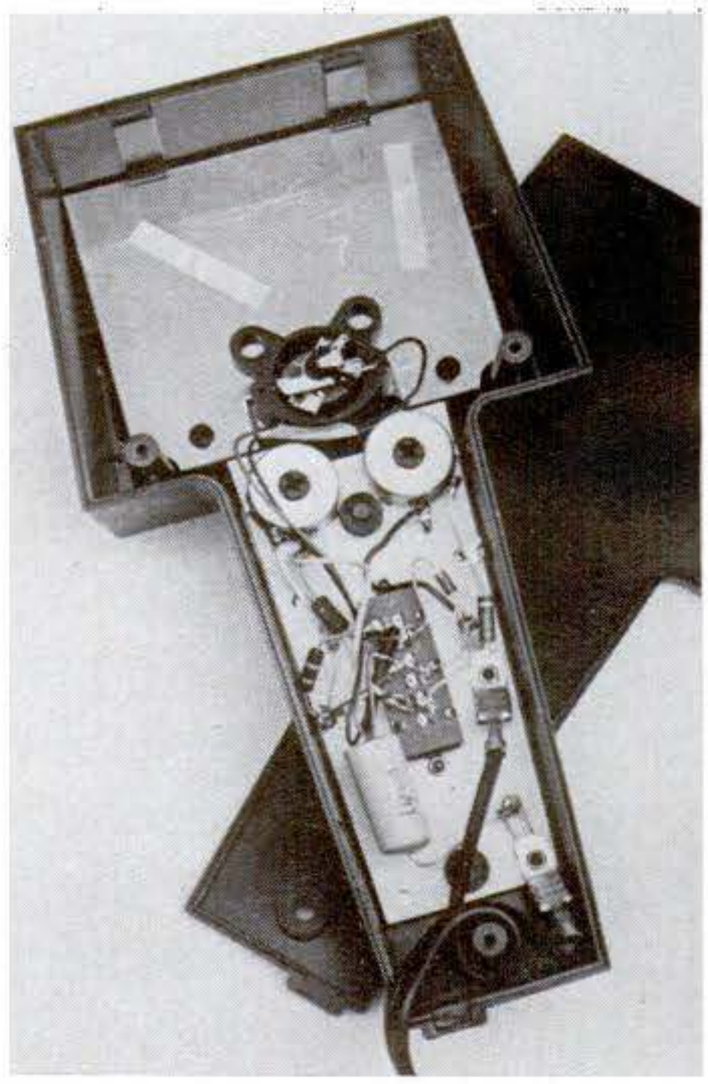
[*Continued*]



When purchasing a dwell tach, check the scale. Is it easy to read? Is the case sturdy? Are the controls easy to use? No need to plug it in for those answers.

Small, inexpensive unit like this may seem a good buy. But you must be willing to put up with small scale and less-sturdy case than with costlier models.

To withstand accidental bumps, your dwell tach should have either a metal case, such as this Marquette unit, or an impact-resistant plastic case.



Most dwell tachs permit easy access to electrical components. With reasonable care, though, electrical malfunctions are not usually a problem with these meters.

for even relatively short periods of time can destroy its effectiveness.

• *PCV-system check.* With the engine idling, remove the PCV hose from the valve cover and put your finger over the valve at the end of the hose. If engine rpm doesn't drop by at least 50, replace the valve and clean the hose.

• *Air-filter check.* If you're unsure about whether your air filter is too dirty, remove the air-cleaner cover and the air-filter and note engine rpm. Then replace the filter and cover. If engine speed decreases after the filter and cover are in place, the air filter probably needs replacing.

Buying a dwell tach

Prices of dwell tachs can range from well under $20 to over $100. How much you pay depends mainly on features. Things to consider:

Is the scale easy to read? Are the controls easy to use? Sun's

Continued

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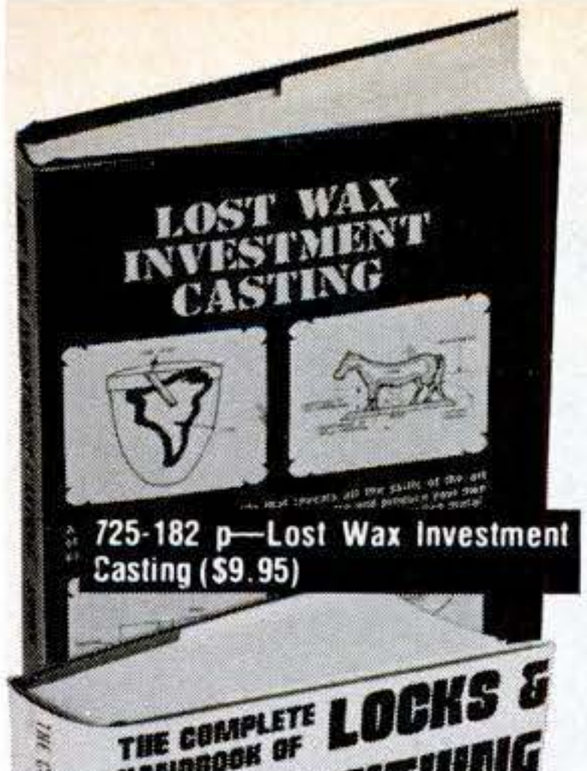

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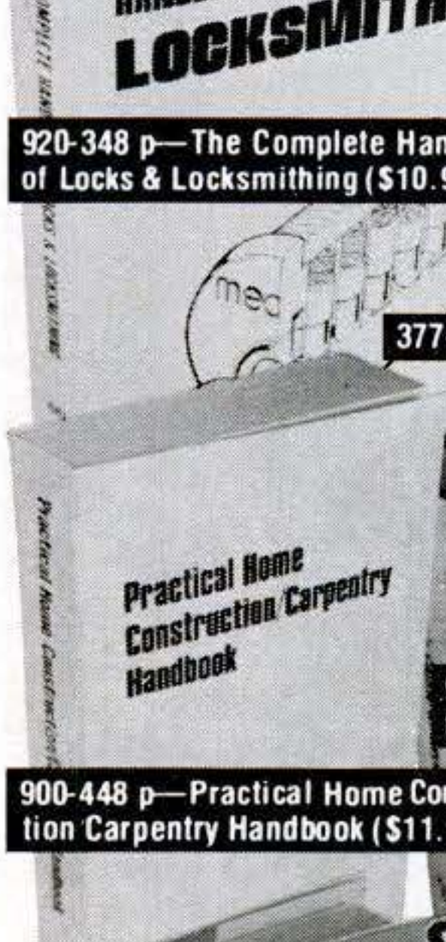

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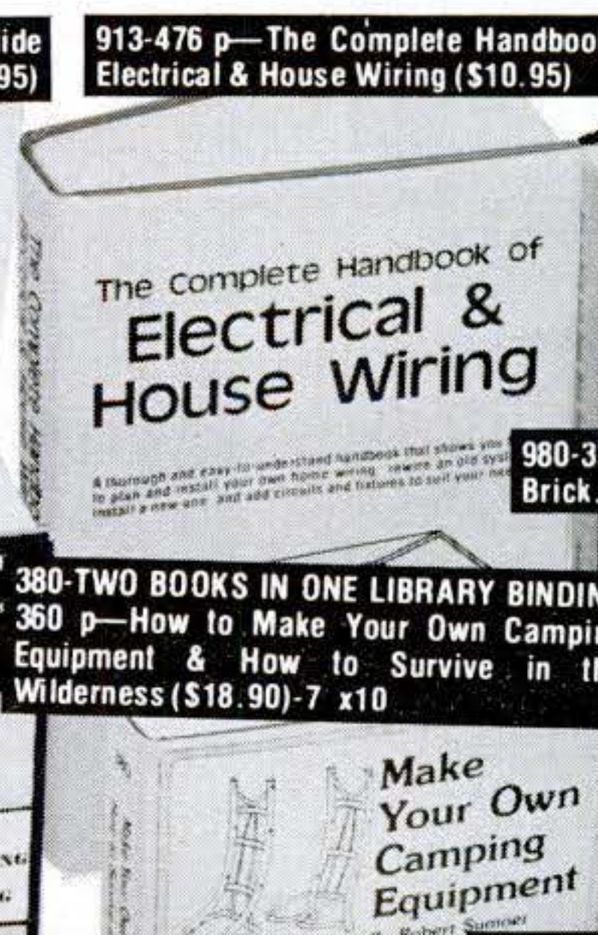

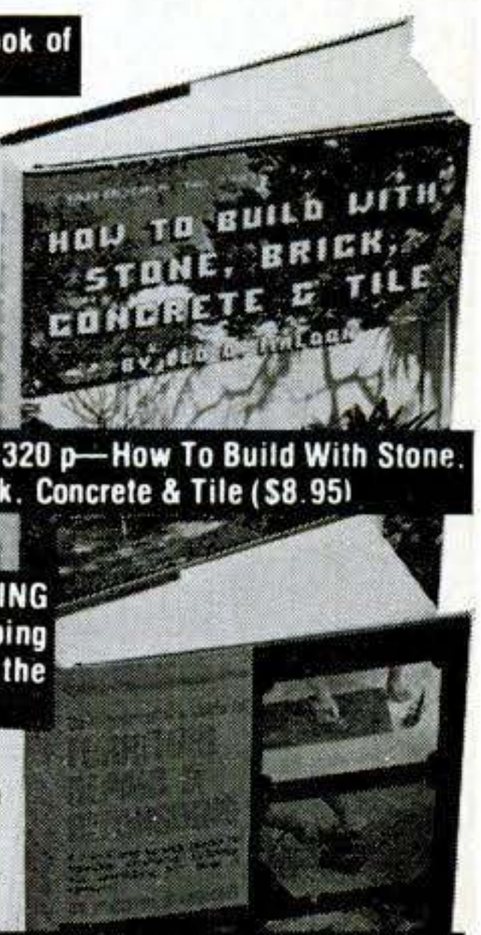

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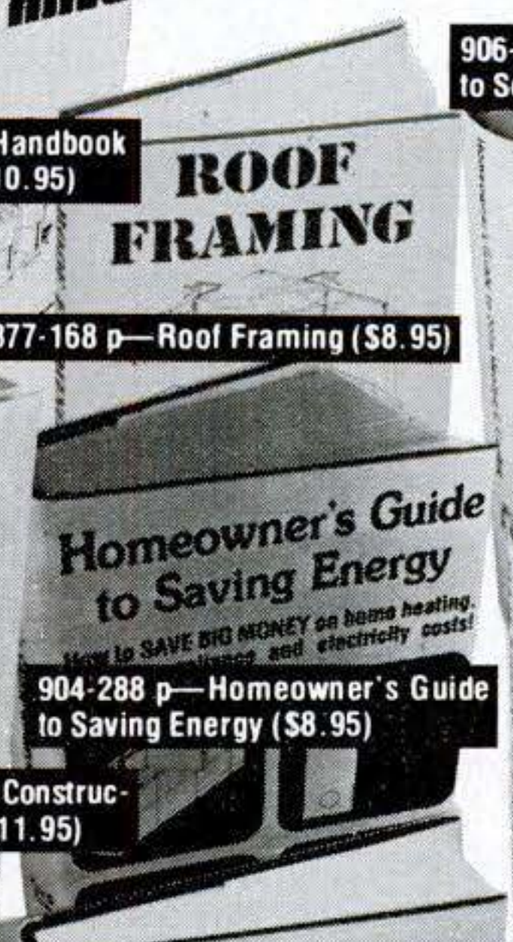

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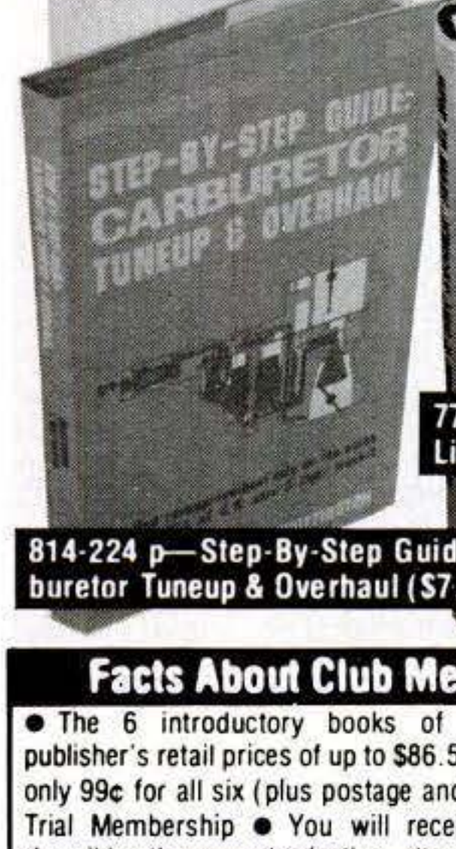

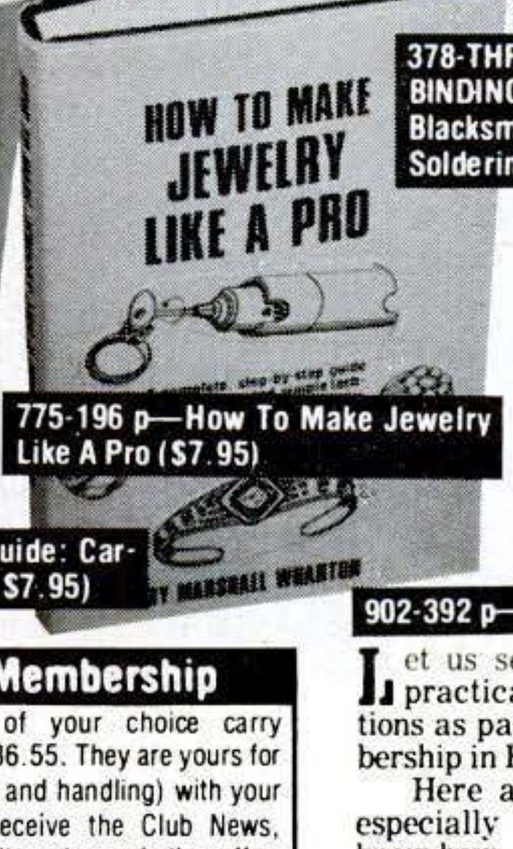

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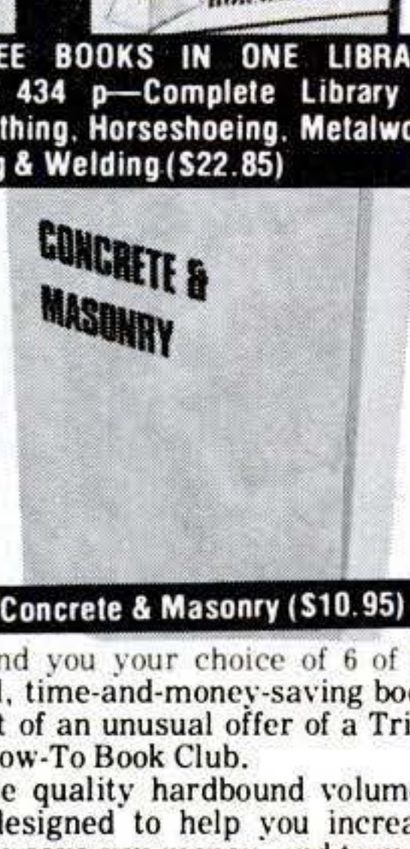

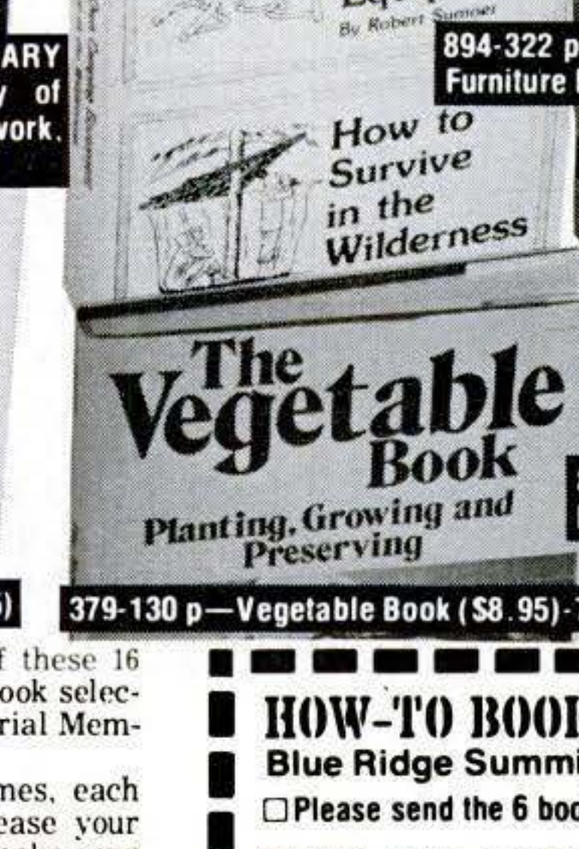

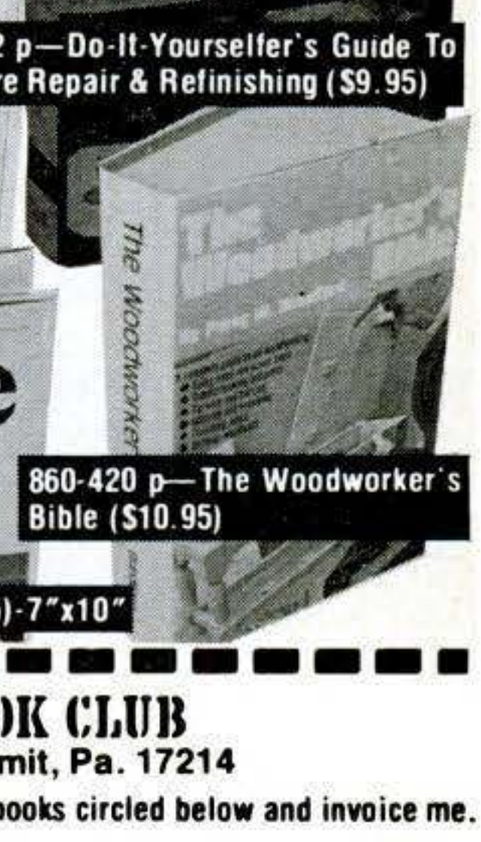

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Dwell tach

[*Continued*]

dwell tach CP 7601 is a good example of excellent design in both areas (see picture on first page of this article). In general, a smaller scale is more difficult to read. Also the scale arrangement has a lot to do with readability. Some scales not only require studying them for several seconds just to figure them out, but additional mathematics just to arrive at a reading. The best scale is one that doesn't require super vision to read, or mental calculations to compute.

A dwell tach is a sensitive instrument, so the case should be rugged enough to withstand a rap against another object. If it's a hand-held model, it should fit in your hand comfortably and not be so heavy that it's tiring to hold.

For most do-it-yourselfers, the best choice is a hand-held unit, or a model that's small and light enough to be portable.

Will it work with electronic ignition? With electronic ignitions, a "black box" takes the place of breaker points, and dwell is controlled electronically. You can't measure it with a dwell meter, and you can't adjust it. That's one of the reasons electronic ignition is superior to breaker-point ignition—the dwell doesn't change—as it does with points. PS

Typical units are shown above. They range in price from less than $20 to more than $100. All these instruments gave virtually identical readings on both breaker-point and electronic ignitions. With electronic ignition, the dwell portion of the instrument is not used, but the tach can be used.

POPULAR SCIENCE

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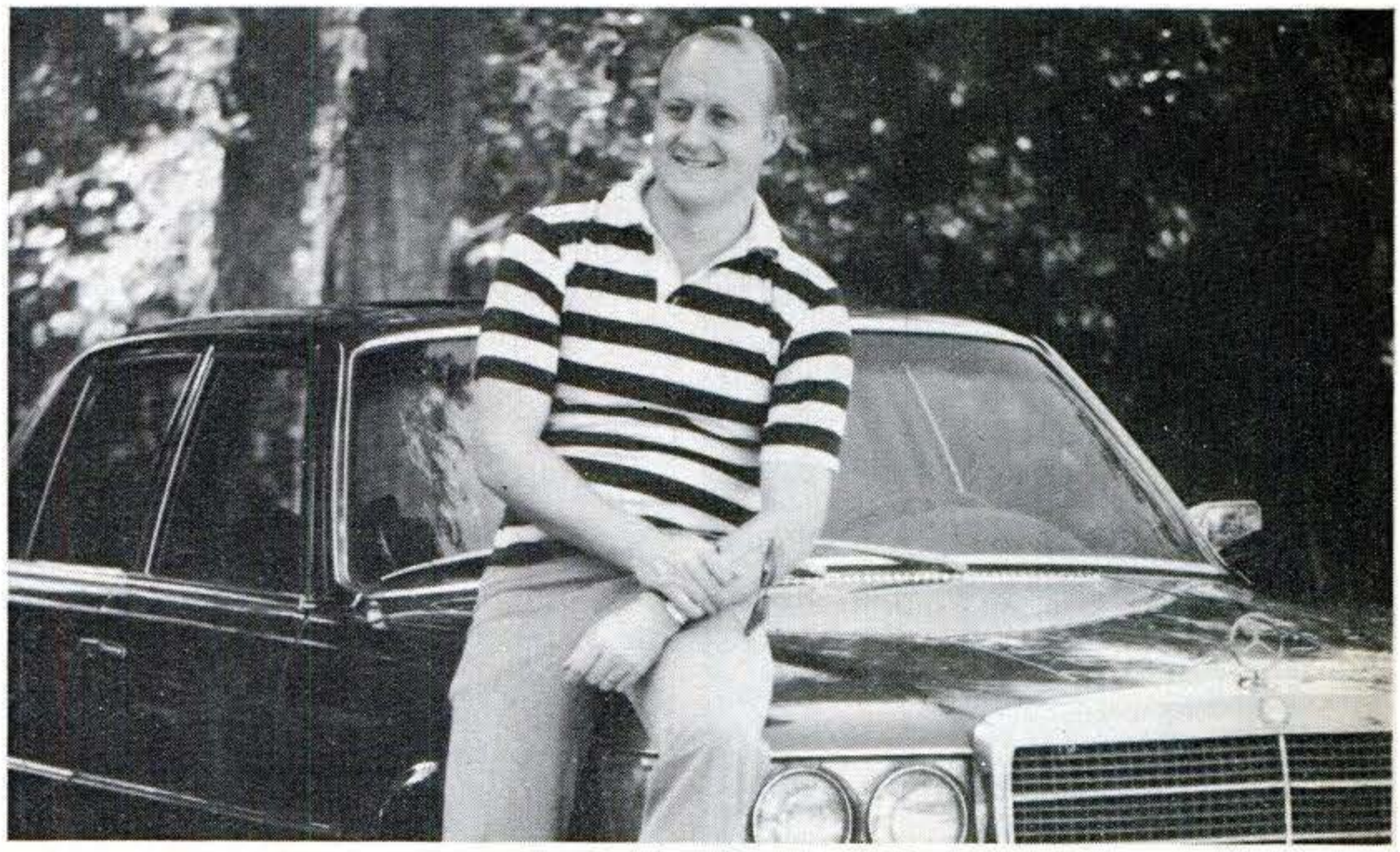
How to Achieve Total Financial Freedom



Mark Haroldsen reached his first million in 48 months:
"I've found that most people just need a very specific financial road map to follow . . . they can do what I've done."

A MUTUAL CONCERN. We've never met and probably never will, but I think we share a common interest. That interest is in achieving complete and total financial freedom.

Recently my net worth reached the *magic million dollar mark,* and it only took me 48 months to achieve that.

That might not impress you, but if you had seen me just a few years ago, you might wonder how I did it. I lived in Denver then, in a cramped, tumbled down house at 2545 South High Street. My wife was expecting our second child and we were so broke we had to borrow $150.00 from a relative just to buy food and pay the rent.

By the way, I know I didn't make a million dollars because of my superior intellect — I barely got through Ames High School (Ames, Iowa) with a C average. I did a little better later on but I soon realized that a salaried job was not the way to become financially free. If you'll stop and think, you'll realize that millionaires do not work 10, 20, or 50 times harder or longer than you.

FINANCIAL FREEDOM. It seems that most people who are charging for financial advice have studied how to "do it" but have never actually "done it" themselves. You will find as you read my formulas, that since I have actually achieved total financial freedom myself, that you will receive from me more than just the motivation to achieve your own financial independence, but a workable step-by-step plan to actually do it.

STEP-BY-STEP. Contained in the work entitled ***How To Wake Up The Financial Genius Inside You*** are the various formulas which will show you exactly how you can do each of the following:

- buy income properties for as little as $100 down.
- begin without any cash.
- put $10,000 cash and more in your pocket each time you buy (without selling property).
- compounds your assets at 100% yearly.
- legally avoid paying federal or state income taxes.
- buy bargains at one-half the market value.

MORE LEISURE. If you apply these formulas and methods you will find in a very short time, you will be able to do almost anything you care to do, and I think, at that time, you will find as I have, that spending several weeks on the beaches of Hawaii, or on the ski slopes of Colorado, or just sightseeing in Europe, or any other place in the world, you begin to understand what **real freedom** is all about.

Most people think that it would be impossible to do some of the things listed above. For example, to buy a property, and at the same time put $10,000 (or more) cash in your pocket without selling the property, or to buy a property with little or no cash down.

Believe me, it is possible and fairly simple. This is exactly how most wealthy people actually do make 10, 20, or 50 times more money than you do.

YOUR MONEY'S WORTH. While I was struggling on making my first million, I often thought how nice it would be to have the personal advice and counsel from someone like Howard Hughes or J. Paul Getty.

What would I have been willing to pay for this service? I can tell you one more thing for sure, it would have been a lot more than the $12.00 that I'm going to ask you to invest in your financial future.

". . . more than 100,000 people have discovered that my formulas will provide the road map that can lead to total financial freedom . . ."

FOR YOUR FUTURE. What will this $12.00 actually do for you? It will give you a complete step-by-step plan that you can follow to become totally and completely financially independent.

Please try to understand my dilemma. I'm not a New York advertising agency with all their professional skill and manpower to write a powerful and persuasive ad to convince you that I can make you financially independent. I am just somebody who has actually 'done it', and can really show you how to 'do it'.

TEST IT YOURSELF. It's really quite frustrating to have something so valuable as I know I have, but lack the skill to convince people to try it for themselves. I hope by my simple direct approach I can convince you to try my formulas.

INDECISION — THE COSTLY DECISION. It seems the majority of the people in our rich country lose, not because they lack intelligence, or even willpower, but because of procrastination, or lack of action — please don't be like the masses. Make a decision while you have this paper in your hands. Make a decision now to either act now and send for my material or immediately round file this paper. If your decision is to order, do it now, not later. Otherwise you may lose, just by default.

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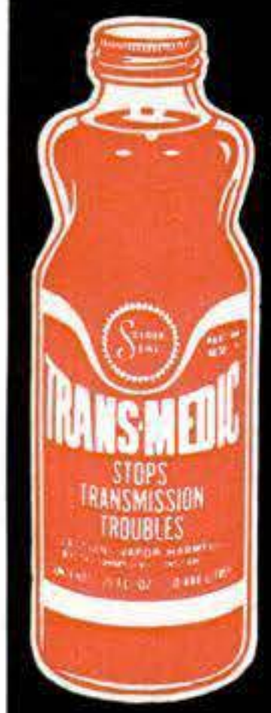

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Re-siding

[Continued from page 122]

finish will look good, compare the length of the warranties. Keep in mind that most warranties are prorated. You probably won't get a new siding job free if 20-year-warranty siding fails in 19 years, for example. Here are some additional thoughts that may be helpful.

- Vinyl may be your best bet if you are primarily interested in the least noticeable disfigurement from scrapes and blows (but even vinyl has been known to crack from heavy impact). One maker who offers a wide variety of re-side materials sees vinyl rapidly increasing in popularity.
- People who sell continuous roll-formed aluminum and steel siding point out that siding in precut lengths has gaps at the unavoidable end joints. That's true, but how serious that is is a matter of opinion.
- Steel and aluminum, being conductive metals, are sometimes billed as particular lightning hazards. But in fact lightning frequently strikes buildings of all types. Metal siding is also accused of interfering with TV reception. While it might affect an inside antenna, it shouldn't make a difference if you have a roof antenna.
- Prefinished hardboard probably offers the greatest variety of colors, styles, and textures. If you're set on a deeply embossed woodgrain, Masonite's cedar texture is perhaps the most authentic.

You may find yourself being swayed toward a particular re-siding material by a dealer or siding contractor. As a representative for one maker puts it: "Generally, the consumer will eventually purchase whatever the contractor wants to install." So check costs of materials and/or installation with a number of different contractors. And buy what *you* want. PS

MAKERS/SUPPLIERS OF RE-SIDING
Alside, Inc. (U.S. Steel Bldg. Products), Box 2010, Akron OH 44309 (steel, vinyl, aluminum); **Aluminum Co. of America,** 1501 Alcoa Bldg., Pittsburgh PA 15219 (aluminum); **Bird & Son, Inc.,** E. Walpole MA 02032 (vinyl); **Boise Cascade,** Wood Products Div., Box 4463, Portland OR 97208 (hardboard); **CertainTeed Corp.,** Valley Forge PA 19482 (vinyl); **GAF Corp.,** Bldg. Materials Grp., 140 W. 51 St., New York NY 10020 (mineral fiber, vinyl); **Johns-Manville,** Greenwood Plaza, Denver CO 80217 (vinyl); **Kaiser Aluminum and Chemical Corp.,** 300 Lakeside Dr., Oakland CA 94604 (aluminum); **Masonite Corp.,** 29 N. Wacker Dr., Chicago IL 60606 (hardboard); **Mastic Corp.,** 131 S. Taylor St., South Bend IN 46624 (aluminum, vinyl, steel); **Revere Aluminum Bldg. Products, Inc.,** 11440 W. Addison St., Franklin Park IL 60131 (aluminum, steel, vinyl); **Reynolds Metals Co.,** Box 27003, Richmond VA 23261 (aluminum); **Rehcon, Inc.,** 5135 S. 135 St., Omaha NE (clad particle board); **Sears Roebuck & Co.,** home-improvement catalog (aluminum, vinyl); **Wood Bros. Bldg. Materials Grp.,** Box 4426, Lincoln NE 68504 (roll-formed aluminum and steel).

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The Ultimate Tax Shelter

by
TED NICHOLAS

Tax experts are now referring to a small, privately owned corporation as "The Ultimate Tax Shelter." This is especially true since the passage of the Tax Reform Act of 1976. This law makes most former tax shelters either obsolete, or of little advantage. Investments affected include real estate, oil and gas drilling, cattle feeding, movies, etc. These former tax shelters have lost their attractiveness. Aside from that, these tax shelters required a large investment. Only a small segment of the population could benefit from them.

I've written a book showing how you can form your own corporation. I've taken all the mystery out of it. Thousands of people have already used the system for incorporation described in the book. I'll describe how you may obtain it without risk and with a valuable free bonus.

A corporation can be formed by anyone at surprisingly low cost. And the government encourages people to incorporate, which is a little known fact. The government has recognized the important role of small business in our country. Through favorable legislation incorporating a small business, hobby, or sideline is perfectly legal and ethical. There are numerous tax laws favorable to corporate owners. Some of them are remarkable in this age of ever-increasing taxation. Everyone of us needs all the tax shelter we can get!

Here are just a few of the advantages of having my book on incorporating. You can limit your personal liability. All that is at stake is the money you have invested. This amount can be zero to a few hundred or even a few thousand dollars. Your home, furniture, car, savings, or other possessions are not at risk. You can raise capital and still keep control of your business. You can put aside up to 25% of your income tax free. If you desire, you may wish to set up a non-profit corporation or operate a corporation anonymously. You will save from $300 to $1,000 simply by using the handy tear-out forms included in the book. All the things you need: certificate of incorporation, minutes, by-laws, etc., including complete instructions.

There are still other advantages. Your own corporation enables you to more easily maintain continuity and facilitate transfer of ownership. Tax free fringe benefits can be arranged. You can set up your health and life insurance and other programs for you and your family wherein they are tax deductible. Another very important option available to you through incorporation is a medical reimbursement plan (MRP). Under an MRP, all medical, dental, pharmaceutical expenses for you and your family can become tax deductible to the corporation. An unincorporated person must exclude the first 3% of family's medical expenses from a personal tax return. For an individual earning $20,000 the first $600 are not deductible.

Retirement plans, and pension and profit-sharing arrangements can be set up for you with far greater benefits than those available to self-employed individuals.

A word of caution. Incorporating may not be for you right now. However, my book will help you decide whether or not a corporation is for you now or in the future. I review all the advantages and disadvantages in depth. This choice is yours after learning all the options. If you do decide to incorporate, it can be done by mail quickly and within 48 hours. You never have to leave the privacy of your home.

I'll also reveal to you some startling facts. Why lawyers often charge substantial fees for incorporating when often they prefer not to, and why two-thirds of the New York and American Stock Exchange companies incorporate in Delaware.

You may wonder how others have successfully used the book. Not only a small unincorporated business, but enjoyable hobbies, part time businesses, and even existing jobs have been set up as full fledged corporations. You don't have to have a big business going to benefit. In fact, not many people realize some very important facts. There are 30,000 new businesses formed in the U.S. each and every month. 98% of them are small businesses; often just one individual working from home.

To gain all the advantages of incorporating, it doesn't matter where you live, your age, race, or sex. All that counts is your ideas. If you are looking for some new ideas, I believe my book will stimulate you in that area. I do know many small businessmen, housewives, hobbyists, engineers, and lawyers who have acted on the suggestions in my book. A woman who was my former secretary is incorporated. She is now grossing over $30,000 working from her home by providing a secretarial service to me and other local businesses. She works her own hours and has all the corporate advantages.

I briefly mentioned that you can start with no capital whatsoever. I know it can be done, since I have formed 18 companies of my own, and I began each one of them with nothing. Beginning at age 22, I incorporated my first company which was a candy manufacturing concern. Without credit or experience, I raised $96,000. From that starting point grew a chain of 30 stores. I'm proud of the fact that at age 29 I was selected by a group of businessmen as one of the outstanding businessmen in the nation. As a result of this award, I received an invitation to personally meet with the President of the United States.

I wrote my book, **How To Form Your Own Corporation Without A Lawyer For Under $50**, because I felt that many more people than otherwise would could become the President of their own corporations. As it has turned out, a very high proportion of all the corporations formed in America each month, at the present time are using my book to incorporate.

Just picture yourself in the position of President of your own corporation. My book gives you all the information you need to make your decision. Let me help you make your business dreams come true.

As a bonus for ordering my book now, I'll send you absolutely free a portfolio of valuable information. It's called "The Incom Plan" and normally sells for $9.95. It describes a unique plan that shows you how to convert most any job into your own corporation. You'll increase your take-home pay by up to 25% without an increase in salary or even changing jobs in many cases. If you are an employer, learn how to operate your business with independent contractors rather than employees. This means that you'll have no payroll records or withholding taxes to worry about. And you'll be complying with all I.R.S. guidelines. "The Incom Plan" includes forms, examples and sample letter agreements to make it possible.

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[Continued from page 110]

getting into one another's way.

If you want a space-saving room divider or serving bar, you can also use floor cabinets. Units with finished backs that have drawers and shelves facing outward are available in many lines.

Floor units generally require the most careful planning. But don't forget wall and tall cabinets. Wall cabinets are especially versatile; they come in different heights and depths as well as widths, so you can increase storage space while getting good decorative effects in alcoves and around windows.

Scrape, slam, and pull

Once you know what you need, shop around. The overall quality of kitchen cabinets is good, but there are plenty of variations, which are often related to price. Unpainted wood is cheapest; it's followed by simpler metal cabinets, and then by higher-styled lines of veneered and solid wood, plastic laminates or coatings on wood, particle board, and other grades of core stock.

Unless you're protecting your budget by buying unpainted cabinets, you should ask about the type and quality of finish. You'll undoubtedly be happiest with a quality resin laminate, or one of the newer baked-on finishes. No matter how elegant their appearance, they should be able to withstand normal kitchen use—and even abuse. Scraping the edge of a coin over such a finish shouldn't raise any varnish or cause visible damage. A dealer who says the finish is top quality shouldn't object to this test.

While you're shopping around, don't be afraid to slam a few doors. The best ones have a solid feel and a firm, no-bounce grip. Many good ones are hinged to stay fully open, but close themselves when you elbow them a bit.

Press down hard on an open door; if it's well-made, its hinges should be able to bear the weight of a climbing child without springing the hinges or its fittings.

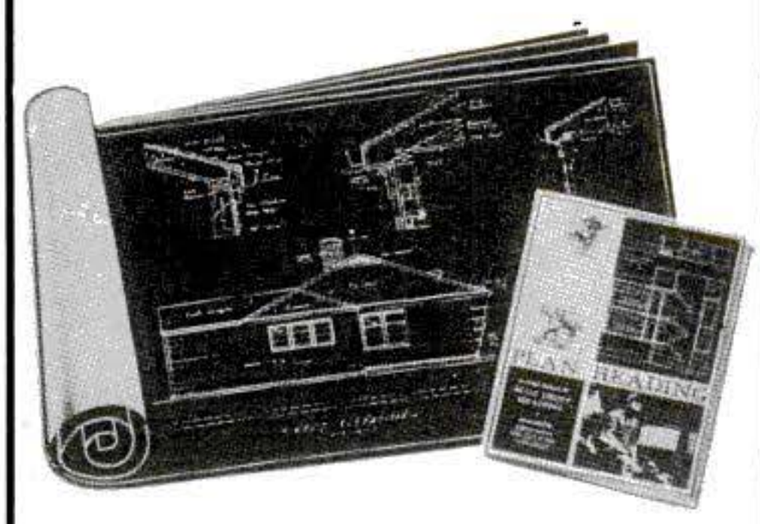
You shouldn't feel any wobble when you shove or lean against a well-made cabinet. And make sure drawers slide out easily on sturdy, tip-resistant guides and rails.

Look inside, too. Joints, if you see them, should be smooth and tight. But many good drawers today don't have visible joints; they are lined with plastic or fitted with molded inserts to eliminate dirt-collecting corners. Door, drawer, and shelf edges should be capped and finished; you should not see any exposed core stock.

A close examination of cabinets in a dealer's stock will tell you most of what you need to know about construction quality. As a final check, look for a certification label from the National Kitchen Cabinet Assn. (NKCA), the trade organization that sets guidelines based on minimum standards for government-funded housing. PS

FOR FURTHER INFORMATION

American Institute of Kitchen Dealers (for lists of clinics in your area), 114 Main St., Hackettstown NJ 07840; **National Kitchen Cabinet Association** (for construction standards), 136 St. Mathews Ave., Louisville KY 40207; **Boise Cascade,** Box 514, Berryville VA 22611; **Coppes, Inc.,** Nappanee IN 46550; **Haas Cabinet Co.,** Sellersburg IN 47172; **Kitchen Kompact,** KK Plaza, Jeffersonville IN 47130; **Merillat Industries, Inc.,** 2075 W. Beecher Rd., Adrian MI 49221; **Sears Roebuck,** Sears Tower, Chicago IL 60684; **Wood-Mode Cabinetry,** Kreamer, Snyder County PA 17883; **Yorktowne,** Box 321, Red Lion PA 17356.



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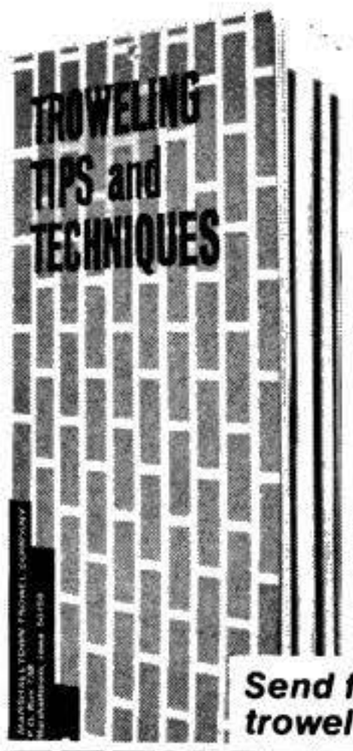

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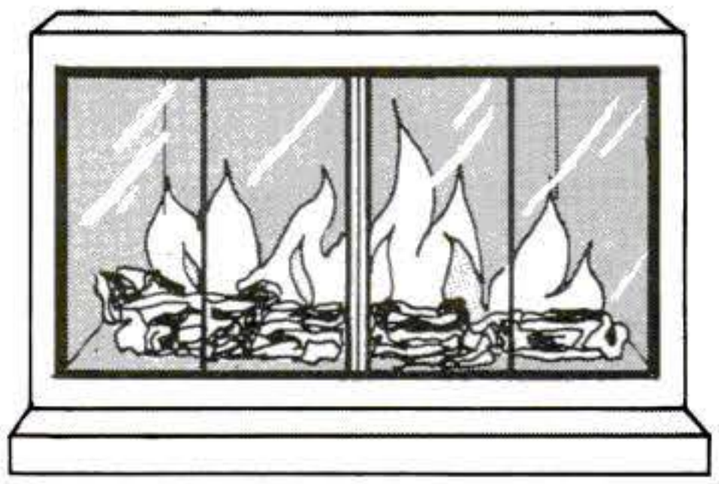

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Insulation upgrade

[Continued from page 150]

above a crawl space, cover the bare earth with 6-mil polyethylene, lapping the sheets several inches and sealing these joints with duct tape.

Be sure the crawl space is adequately ventilated—especially in summer. With a properly laid vapor barrier, you need a square foot of vent opening for each 150 sq. ft. of ground area. Spot openings for cross ventilation.

● *Crawl-space walls.* In some instances, it's preferable to insulate the foundation walls rather than the floor above a crawl space. If the area is large, it's both easier and cheaper, since fewer batts will do the job. Also, in homes with partially excavated basements, the crawl space may flow directly out of the heated basement, and it's easier to insulate its walls than to partition it off. Finally, if there are exposed, underfloor ducts and water lines, it's simpler to treat the whole area as an underfloor plenum.

This is, of course, impractical if the crawl space is ventilated as described above. You'd first have to plug all the foundation vents—at least during the heating season. Also, insulating perimeter walls can be risky in extremely cold climates (Minnesota, Maine); stick to floor treatments there.

I prefer to lay the ground cover first, even though you risk tearing or bunching it as you move along the walls with the insulation. Since each batt must extend at least two feet over this film, it's a two-man chore to slip the film in place after the batts are installed. I'd rather remove my shoes and strap on knee pads to avoid damaging the film.

To be sure the batts stay in place (especially if you unplug foundation vents for summer ventilation), lay scrap lumber along the corner.

● *Ducts.* If they're used for heating only, you don't need a vapor barrier. If they double as air-conditioning ducts, you need a barrier around the outside of the insulation. Commercial duct insulation has this barrier already attached.

● *Back of wall.* The Home Institute sketches show correct installation for "reverse-flange" insulations—working from the rear of a wall or under a floor. I've used the sketches with reluctance, however, since they can be misconstrued. One caution: One of the frequent errors made with insulation is to install it with the vapor barrier toward the cold side of wall, ceiling,

Continued

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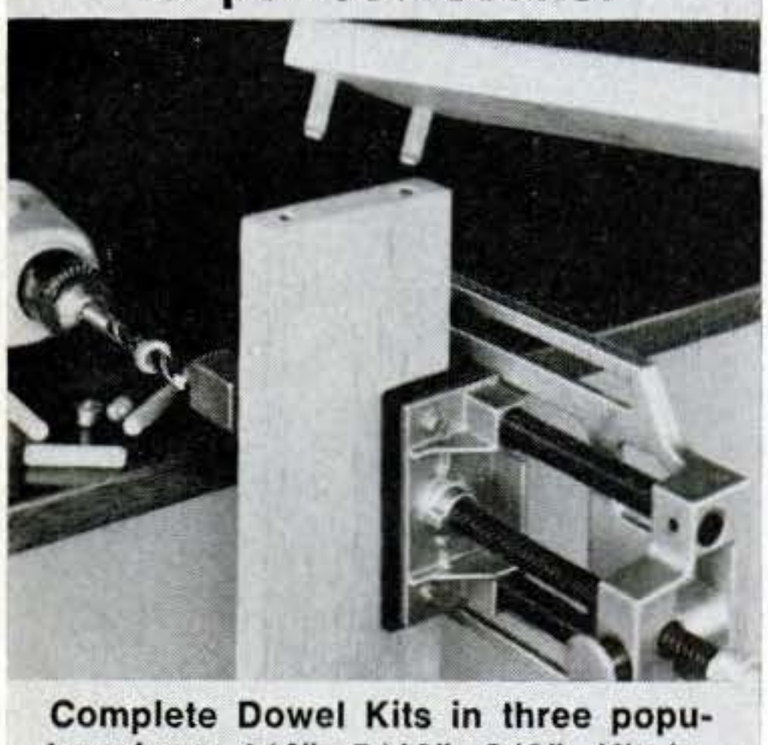

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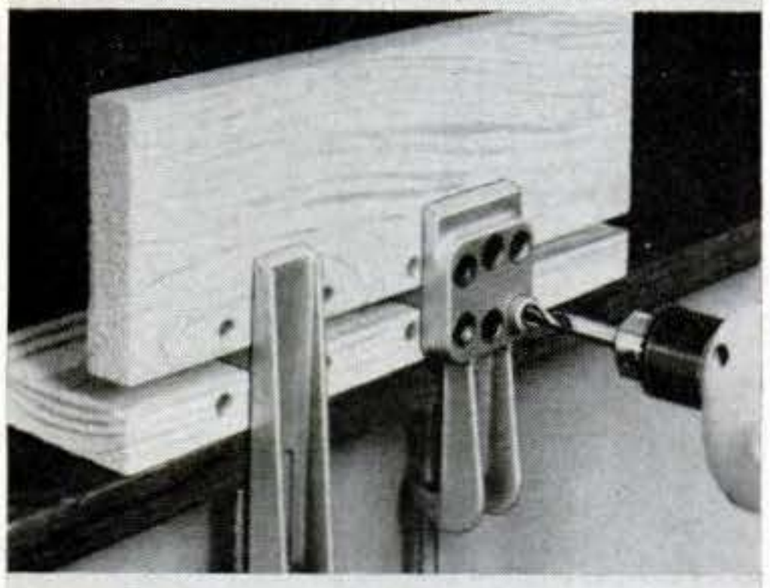

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Insulation upgrade

[*Continued*]

or floor. This short-circuits the fiberglass by inviting condensation *within* it (wet insulation is of little thermal value, and can introduce structural damage to a house). So, let's stress again that the *breather* face on reverse-flange batts is *not* a vapor barrier, and is the *only* facing that can ever be put toward unheated space.

• *Cathedral ceilings.* If you have them in a house more than ten years old, you may be paying dearly for that exposed-beam effect. Builders have only recently grasped how energy-wasteful no-attic construction can be. When a living room's ceiling is the underside of the roof, rigid insulation must be laid over the roof sheathing before the shingles are applied. If you lack such insulation, but want to retain the exposed-beam effect, take a tip from a current Air Force upgrading of base housing (see photo). You can buy room-length thermal ceiling panels to fit between the beams. These fire-safe panels have a textured, prefinished vinyl surface and are 2″ or 3″ thick (for R-8 or R-12, respectively).

Thermal panels can also be the answer to the problem of heating old high-ceilinged rooms. Suspend a metal grid at conventional ceiling height and lay them in. For details, write Owens-Corning (address below) for a ceiling planner brochure.

I haven't begun to cover all the areas in a home you should check for heat loss—and I've limited my tips to fiberglass products. We've told you about other kinds of insulation in past articles (several types require professional installation—not practical for small upgrade jobs). And, of course, insulation is only part of the home energy-saving picture. You've also got to seal against air infiltration (with caulking and weatherstrip). And make certain your windows and doors are doing the best job they can; we have separate articles on upgrading these in the works for winter issues. PS

WRITE FOR FURTHER DATA
The "big three" in fiberglass all offer product and installation brochures:

• **Owens-Corning Fiberglas Corp.,** c/o R. P. Meeks, Fiberglas Tower, Toledo, Ohio 43659, will send a free brochure on reducing heating and cooling costs. Ask for 5BL7907—and also (for cathedral or dropped ceilings) the ceiling planner mentioned in the text. O-C also makes full-width batts in photo and new High-R foil-faced foam board.

• **Johns-Manville,** Box 5705RP, Ken-Caryl Ranch, Denver, Colo. 80217, has a new guide to insulation; ask for HIG-266A.

• **CertainTeed Home Institute,** Box 860, Valley Forge, Pa. 19482, will advise on specific insulation problems and has standard-installation literature.

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Hi-fi loudspeakers

[Continued from page 73]

at the very bottom. But on the basis of what I heard from such vented models as the B.I.C.-Venturi speakers ($80 to $445) and the previously mentioned Pioneer HPM series ($150 to $500), I'd say those lows are quite good. Perhaps they're a little on the heavy side, but the boom is definitely gone.

A variant of the vent is the passive radiator in which the vent is covered by a so-called drone cone. The drone is a regular woofer cone minus the magnet and voice coil. It moves in phase with the main woofer, being pushed by the back pressure dammed up in the vent. The mass of the drone cone lowers the resonance of the vent and the cone's motion projects additional bass. Electro-Voice pioneered this design in its Interface speakers, and the design has since been adopted by several other manufacturers, including Sony and Panasonic.

A few recent models have ventured a long way from established norms. For example, Koss—otherwise famous for earphones—revived the concept of the electrostatic speaker, which has never met much success in the past. But Koss seems to have broken through the technical bottlenecks.

The Koss Model One consists of four panels of flat, metal-coated film stretched between wire-mesh electrodes. A high DC bias (7500 volts) is applied to the metallized film and the audio signal is connected to the adjacent wire mesh. The film then vibrates according to the electrostatic attraction and repulsion between the DC on the film and the varying signal voltage on the mesh.

That way, the total radiating surface of 19 square feet, being pushed equally and simultaneously at all points, moves uniformly. The uniform motion of the entire panel minimizes distortion, and the silvery highs and translucent sound texture of the Koss are characteristic of this type of speaker. What surprised me was the low end, traditionally the weak spot of electrostatics. Unlike earlier designs of this type, the Koss puts out a bass like granite. Well-heeled audio fans may find it worth the $1050 asking price, plus the cost of feeding each speaker 75 watts.

The same notion of a flat, vibrating panel, pushing the air like a jiggling wall, also lies behind the unique Magneplanar speaker. A plastic film stretches across a tall frame in front of an array of bar magnets. Six feet high, four feet wide, and just an inch thick, these panels look like room-divider screens. All the way down the sheet of plastic film runs a zigzag wire carrying the audio signal. The signal current interacts with the magnetic field, moving the plastic. It takes about 50 to 80 watts per channel to drive these power-hungry speakers, yet their sound is strangely anemic. They are certainly sweet and clear, but skimpy at the low end. In fact, they cut off at around 50 Hz. So they're definitely not for rock fans—especially at $625 per pair.

Philips of Holland chimes in with another radically offbeat concept: a compact little speaker (15 by 11 by 8 inches) with a surprisingly big sound and crammed with unique features. It contains its own 40-watt dual-power amplifier (separate amplifiers for woofer and tweeter) plus a feedback-control loop. A tiny strain gauge attached to the woofer cone senses the cone motion and feeds back a proportional voltage to the amplifier output. If the cone motion strays from the true waveform, the amplifier instantly applies a corrective signal. This permits the eight-inch woofer to make long, powerful thrusts—creating a strong bass—without flipping out of control and into distortion. The sound of the Philips RH-535 seemed remarkably true—nothing spectacular, just natural and easy. The $365 price tag reflects the fact that each speaker comes with its own power amp.

Feedback speaker control is also used by Audio International in two models priced at $200 and $600. Here the woofer cone motion is monitored through the back-EMF generated by the voice coil as it moves along the magnet. A separate $75 unit contains the comparison circuit, which is connected back to the input of the main amplifier to complete the feedback loop.

If you decide to check out any of these unusual items for yourself, keep in mind that matching your individual taste—picking a speaker that sounds just right to you—is most important. The hallmark of a good speaker is a realistic balance between highs and lows, clarity and smoothness. PS

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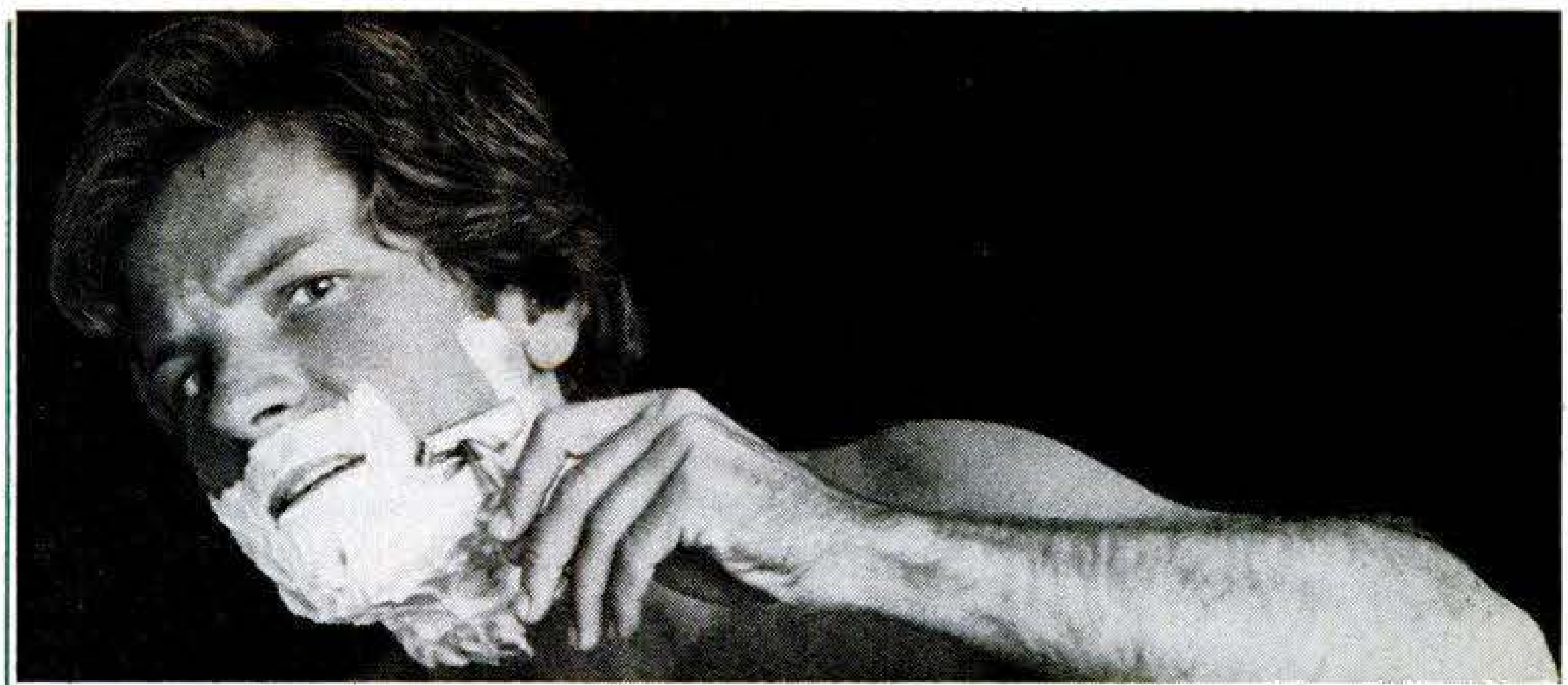
Cook-out pole

[Continued from page 124]



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a 90-degree angle; insert the block jig, the stock, and a T fitting into a metalworking vise and compress the jaws. The curved back portion of the fitting serves as the fulcrum.

Remove the work from the vise, and take the small block jig and clamp it, together with the T, to the bent section of the bar. This will prevent slippage during further bending and drilling. Open the vise jaws as far as possible, then bend the L-shaped bar by hand until it forms a tight V that fits into the vise jaws. Tighten the jaws until the sides of the bar touch the sides of the fitting and form a U. The raised thick part on two sides of the fittings should be ground flat at midsection. This allows the bar to make full contact along the sides of the fitting.

Remove the assembly from the vise but leave the clamp, block, and fitting intact until you've drilled the hole for the bolt. Bore a 21/64″ hole clear through, as indicated. Mark each fitting and bar for later matching.

Return the bar and fitting to the vise, positioned so that the flat end of the T is in line with the top of the jaws, with the U upright. Bend down the legs of the bar until they are horizontal (like the wings of a plane). Grip close to the vise with both hands to make this bend (see photo).

Trace the inside outline of this bend onto a piece of ¾″ plywood to make the large-radius bending jig. The brackets for the grills are bent only partway out to form a V.

Using the jig

The single jig can be used to make the variously sized bends if you start with the largest curve, then progressively cut the jig smaller, as indicated. Angled notches in the jig seat a bar clamp.

Clamp the looped section of the bar against the edges of the projection on the jig, then clamp the jig to the worktable and the bend by pressing the bar, by hand, against the jig. Use a bar clamp to help bend the last few inches. Note that the jig radii are cut 3″ smaller than the required final radius to compensate for springback.

Cut off the bracket ends to the lengths indicated and install the T with a bolt and nut. To attach the bracket on the charcoal pan, clamp it to the rim while drilling holes for 8/32″-by-½″ screws. Secure with nuts. Attach the brackets to the wood members with No. 8 full-thread 1¼″ wood screws.

The grill brackets are notched ¼″ wide and ¼″ deep to allow the rim and cross-brace members to seat flush with the top edge. Four ¼″-by-¼″-by1″ aluminum blocks are used on the perimeter of the rim to secure the grill. Bore a hole through one end of the block and through the bracket to receive 8/32″-by-1⅜″ screws with lock washers and nuts. These blocks can be swung out of the way to release the grill for cleaning.

The basket is attached to the supports with ⅝″ round-head screws—four through the bottom and eight through the upper rim. To ensure that the brackets will be vertically aligned, temporarily insert the pipe post while boring screw holes through the basket rim.

To provide solid anchoring, the ¾″ pipe post is joined with a coupling to an H base made of ¾″ pipe and T fittings. Set the base into a foot-deep hole and prop it up at the corners so cement will surround it. Pour in about 6″ of cement, then backfill. The coupling set above ground serves as a stop.

Adjust each component with a level and tighten the bolts firmly after adjusting the setscrews until they almost touch the post. A length of 1″ PVC pipe is inserted over the pipe section behind the basket to give it a thicker appearance. A 3″-diameter turned redwood ball is used to cap the post. If you don't have a lathe, you can buy a wood finial (of smaller diameter) at most lumber yards.

The cutting-board tops should be finished only with vegetable oil. All other exposed wood surfaces and the PVC sleeve can be painted. Spray aluminum paint on all pipe fittings before final assembly so you can reach the inside threads, which are otherwise prone to rust. PS

MATERIALS LIST

Aluminum bar:
- 3 pcs. ¼″ x 1″ x 8′ (Reynolds 1822)

Galvanized pipe:
- 1 pc. ¾″ x 40″
- 6 pcs. ¾″ x 6″
- 1 pc. ¾″ x 12″

Galvanized fittings:
- 6 pcs. 1″ T
- 1 pc. 1″ coupling
- 1 pc. ¾″ coupling
- 3 pcs. ¾″ T

Lumber:
- 1 pc. ¾″ x 2′ x 6′ exterior plywood
- 1 pc. 4″ x 4″ x 6″ redwood block

Miscellaneous:
- 1″ x 20″ PVC pipe
- Plastic basket
- Barbecue pan with extra grill
- Screws, nuts, bolts, washers (nonrusting)

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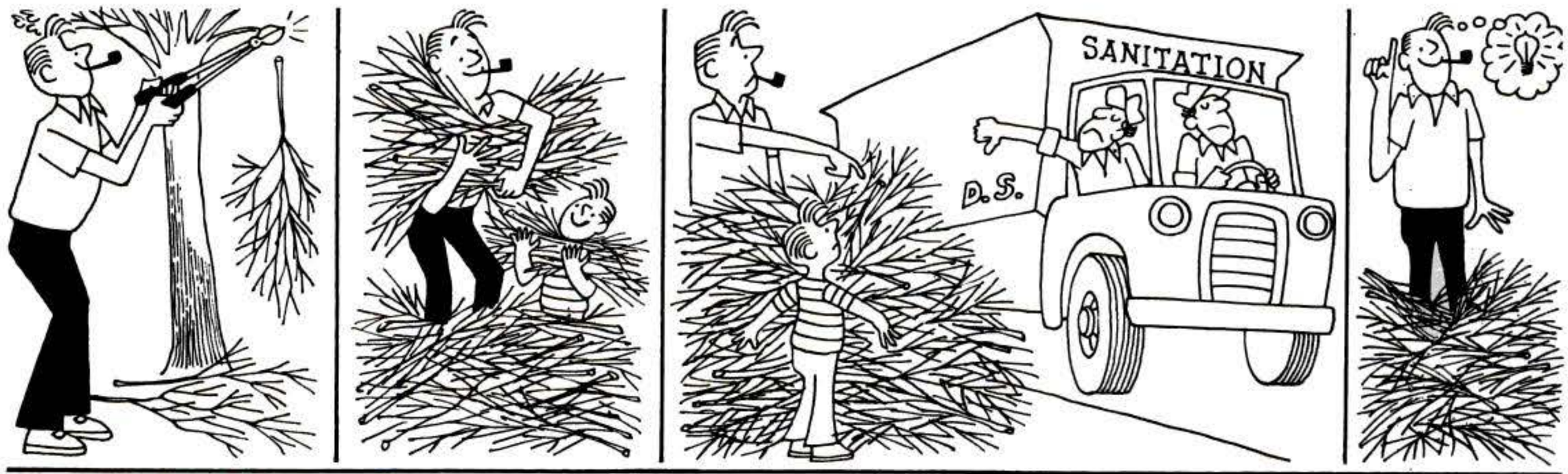
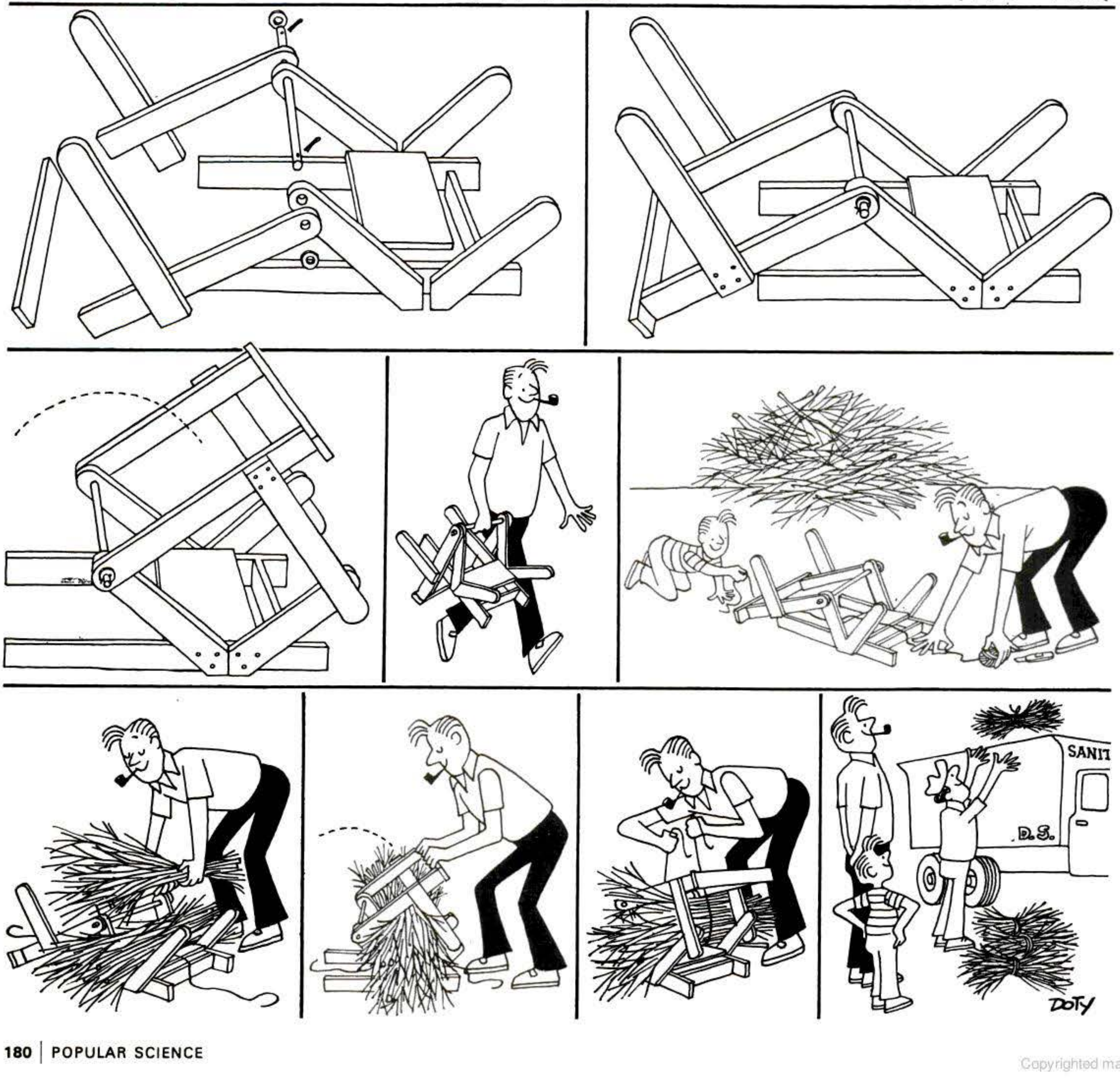
WORDLESS WORKSHOP

By ROY DOTY

$25 to Raymond Singer, So. Orange, N.J., for the idea from which this was adapted. Send yours (with Social Security No.) to Wordless, Popular Science, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas acknowledged.





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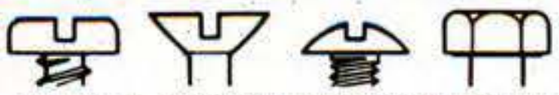

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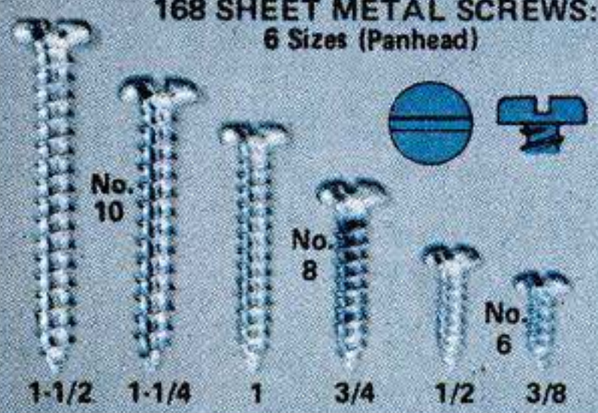

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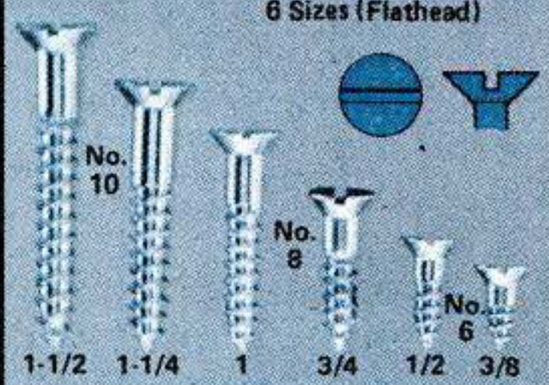

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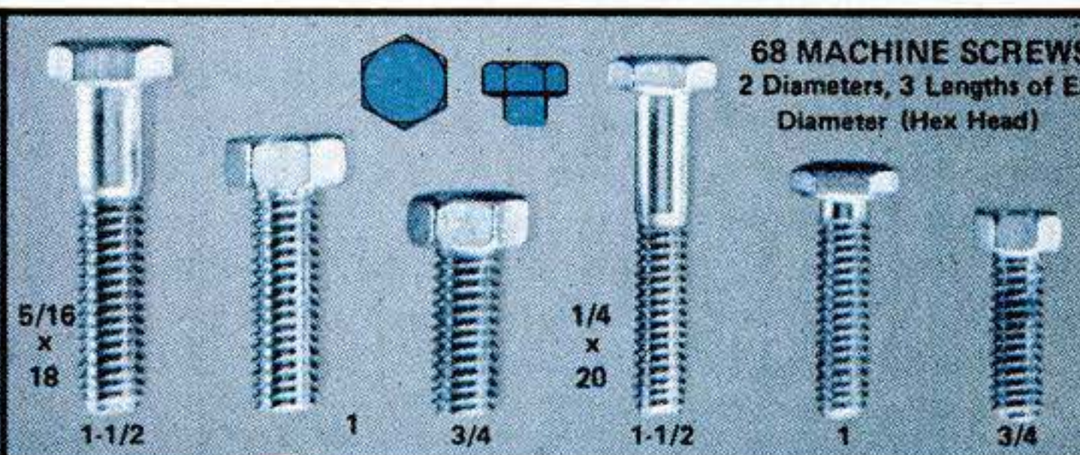

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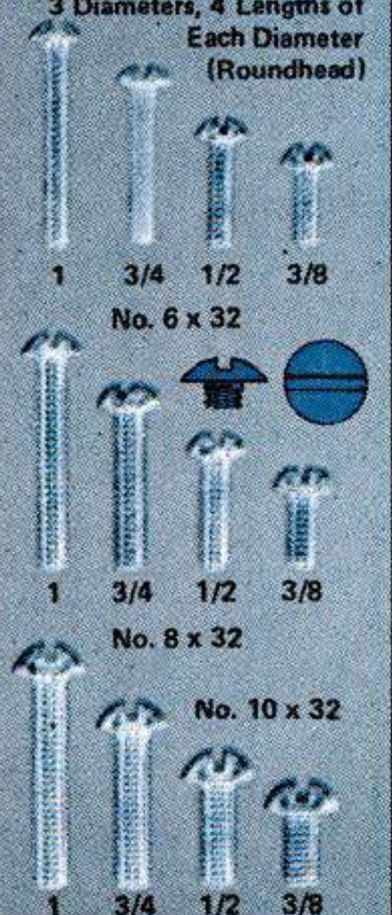

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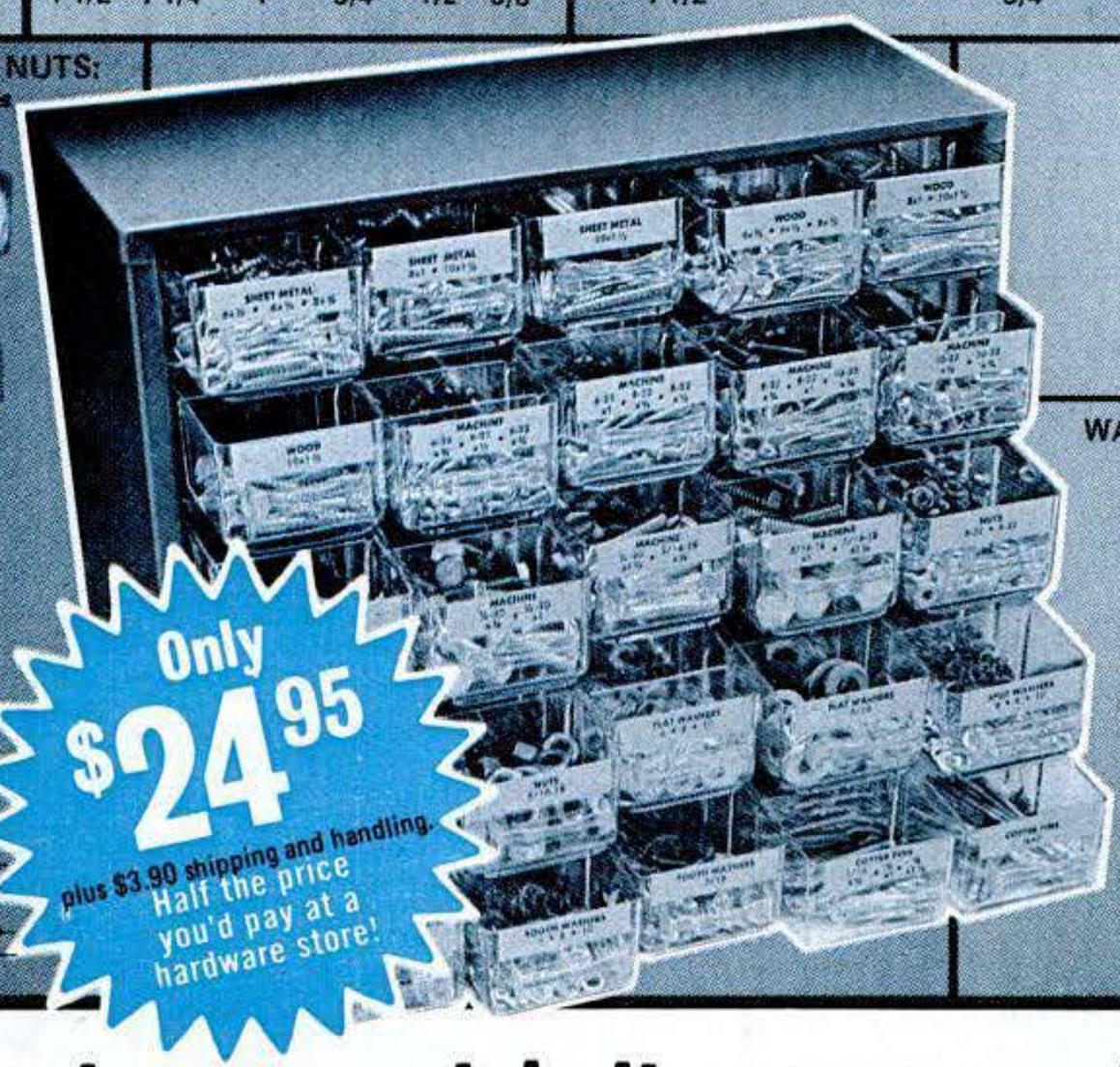

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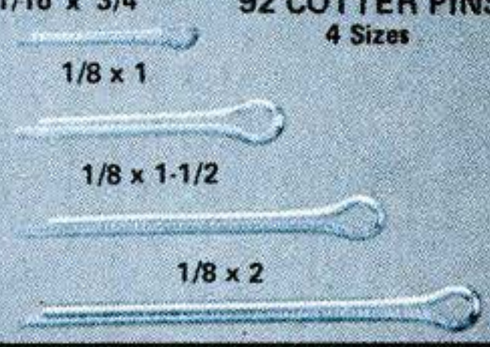

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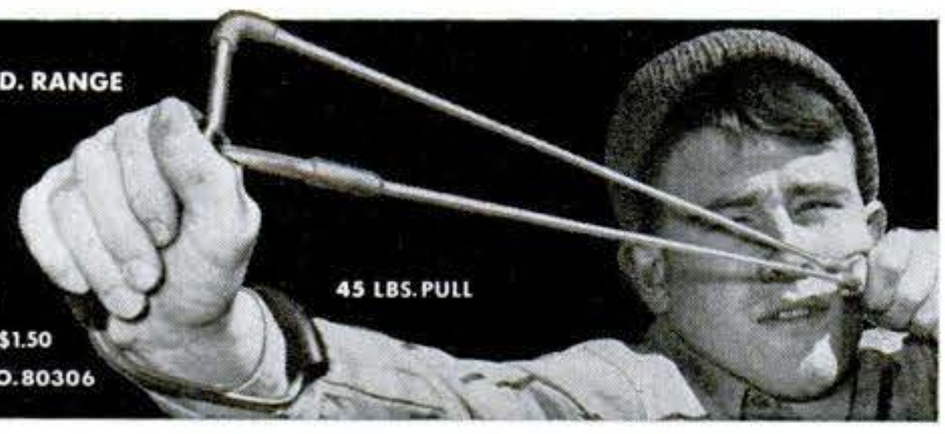

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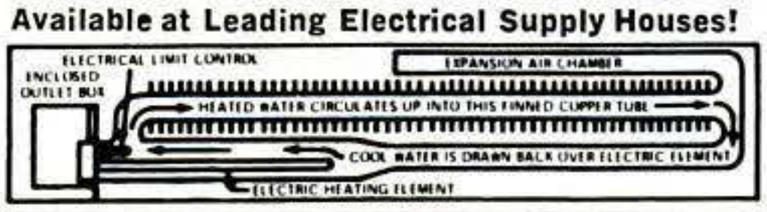

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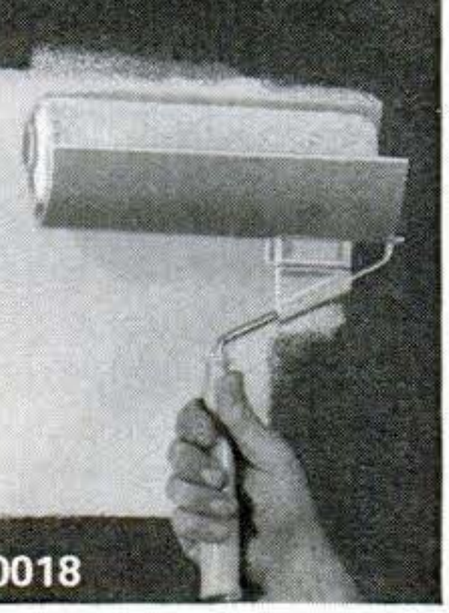

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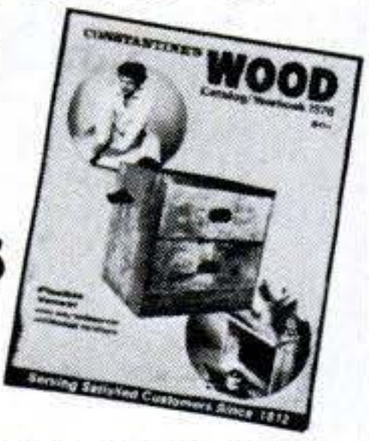

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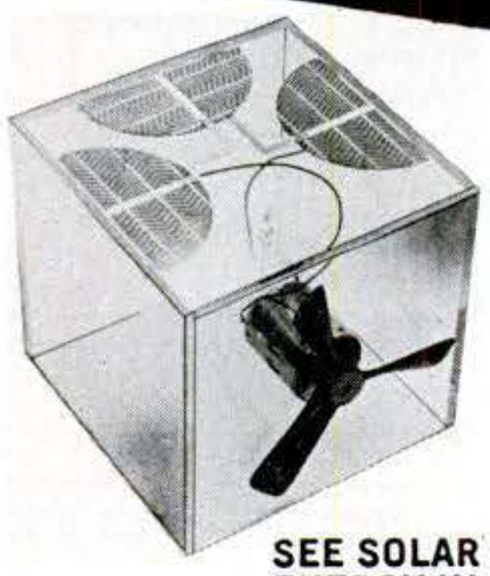

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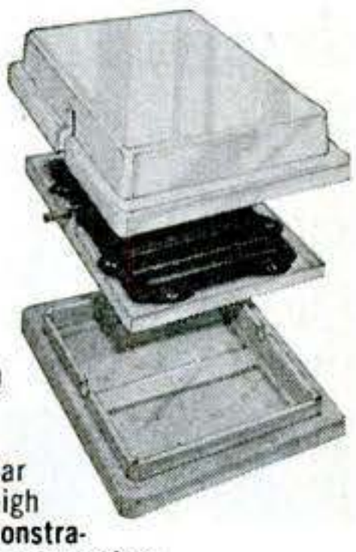

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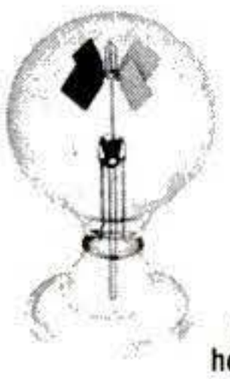

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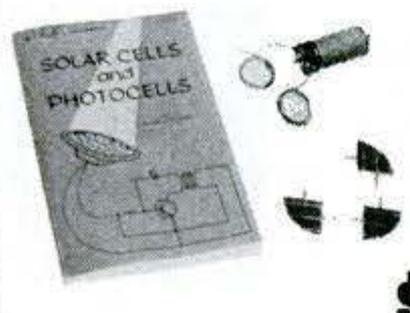

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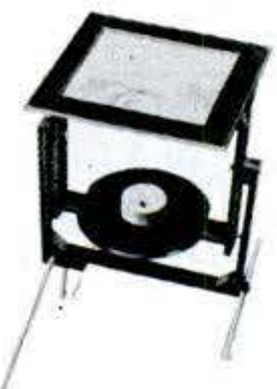

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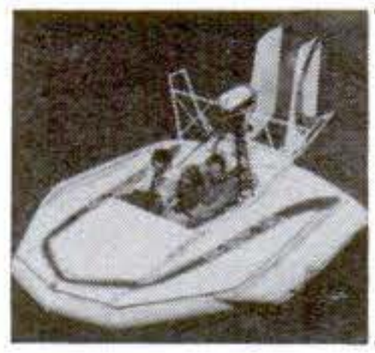

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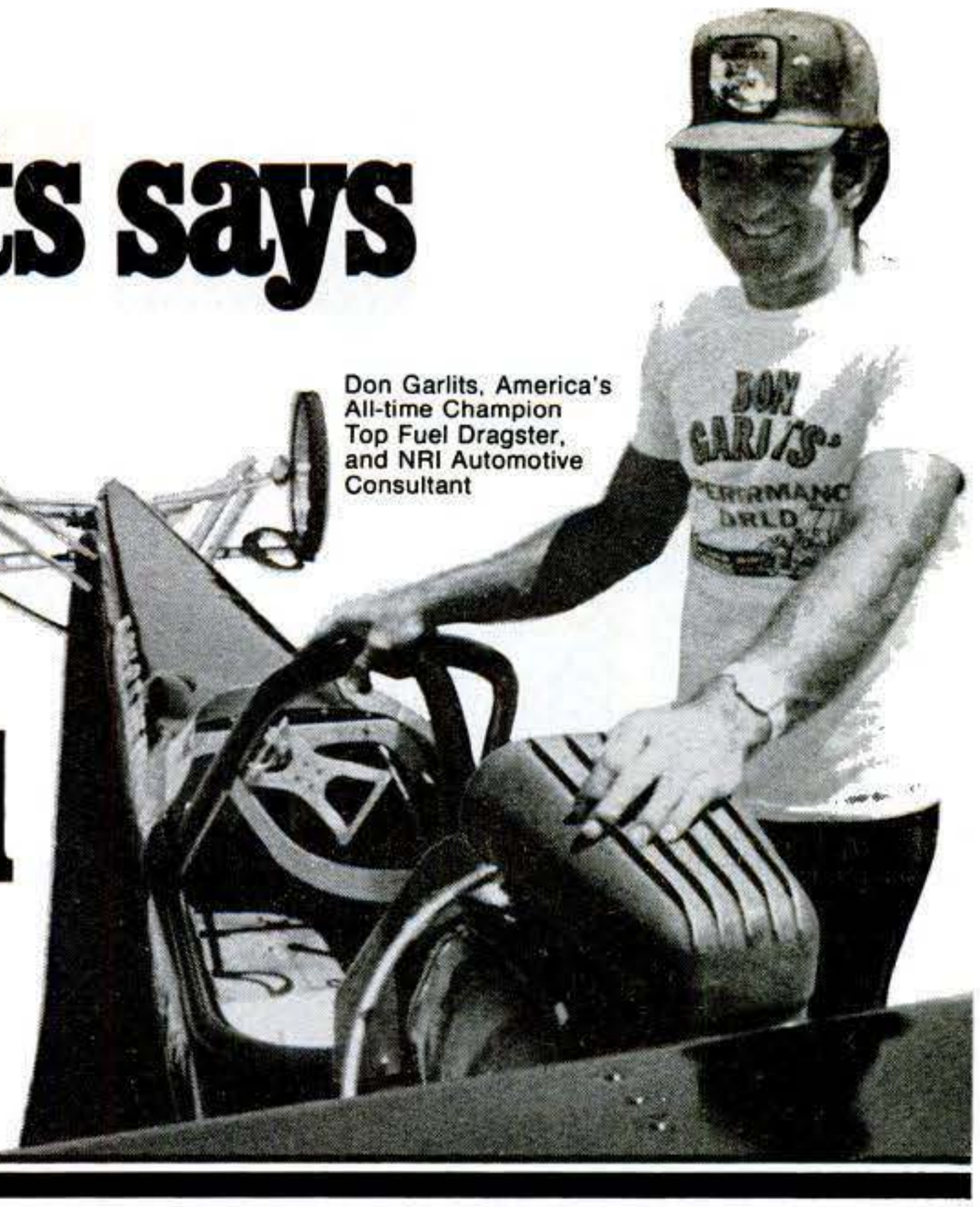

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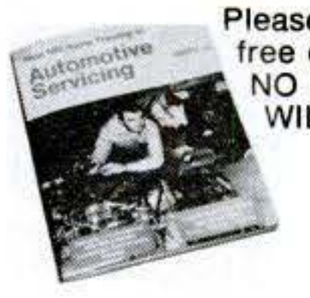

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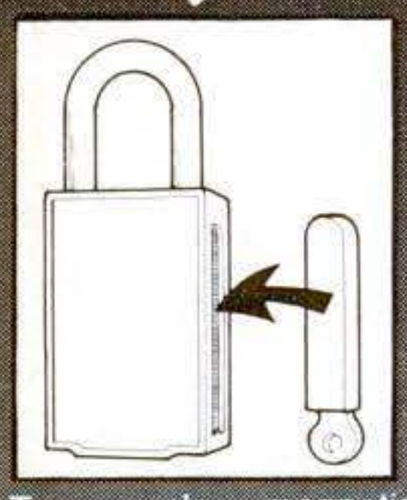

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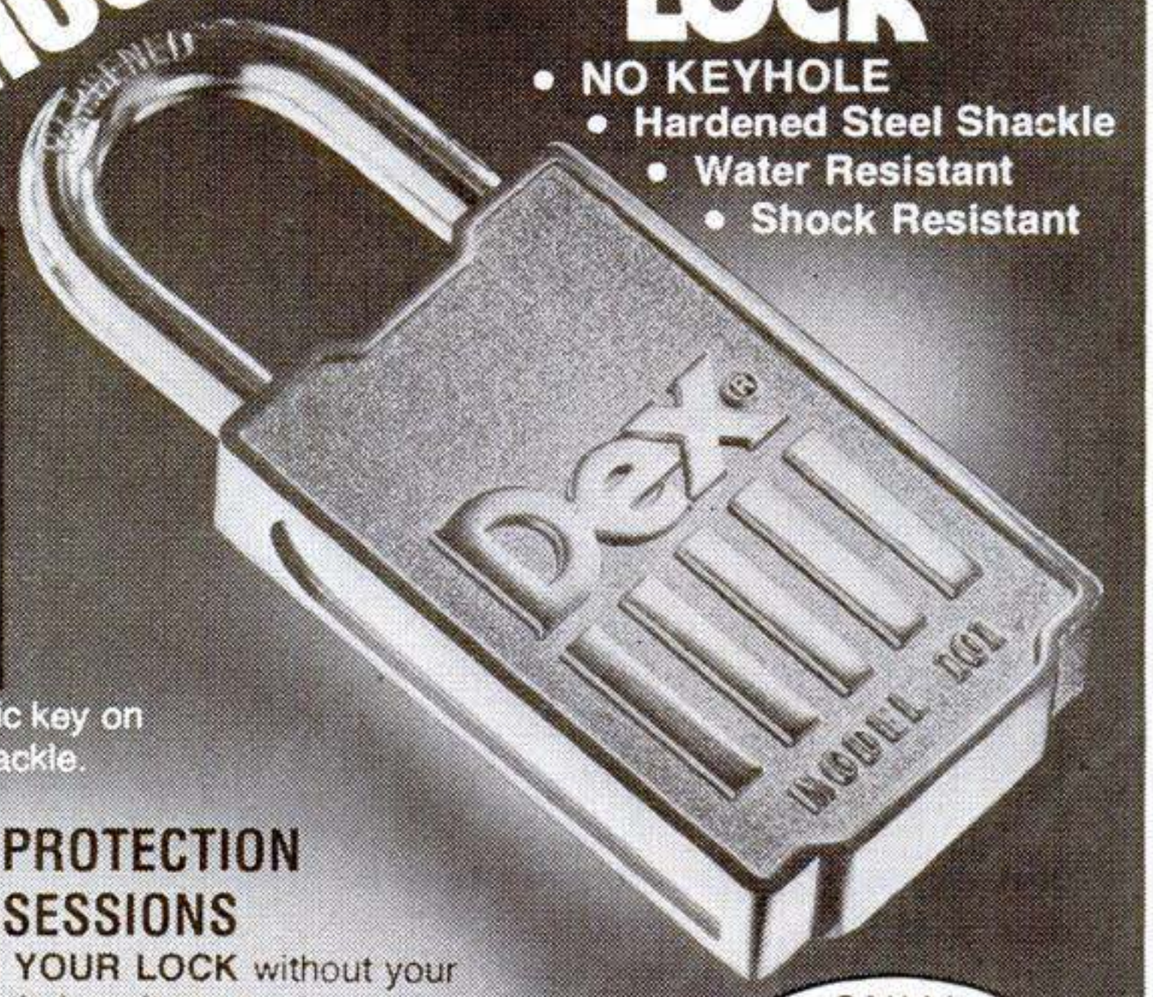

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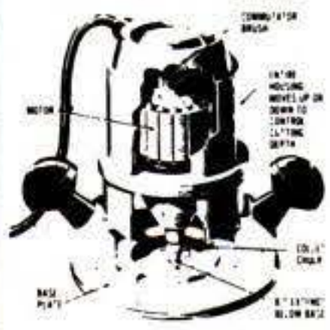

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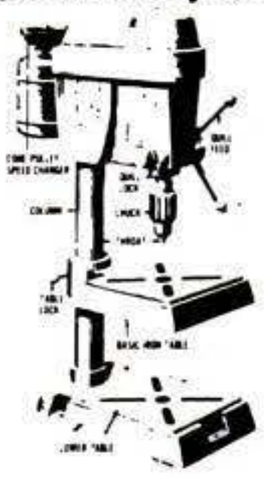

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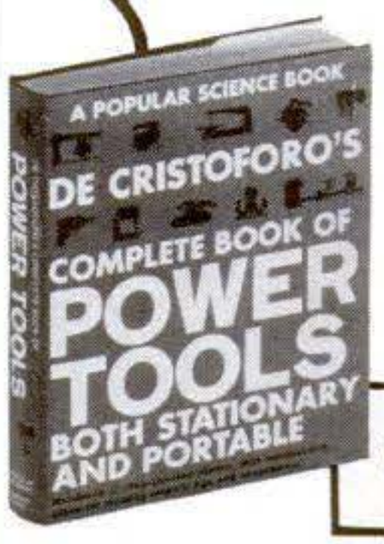

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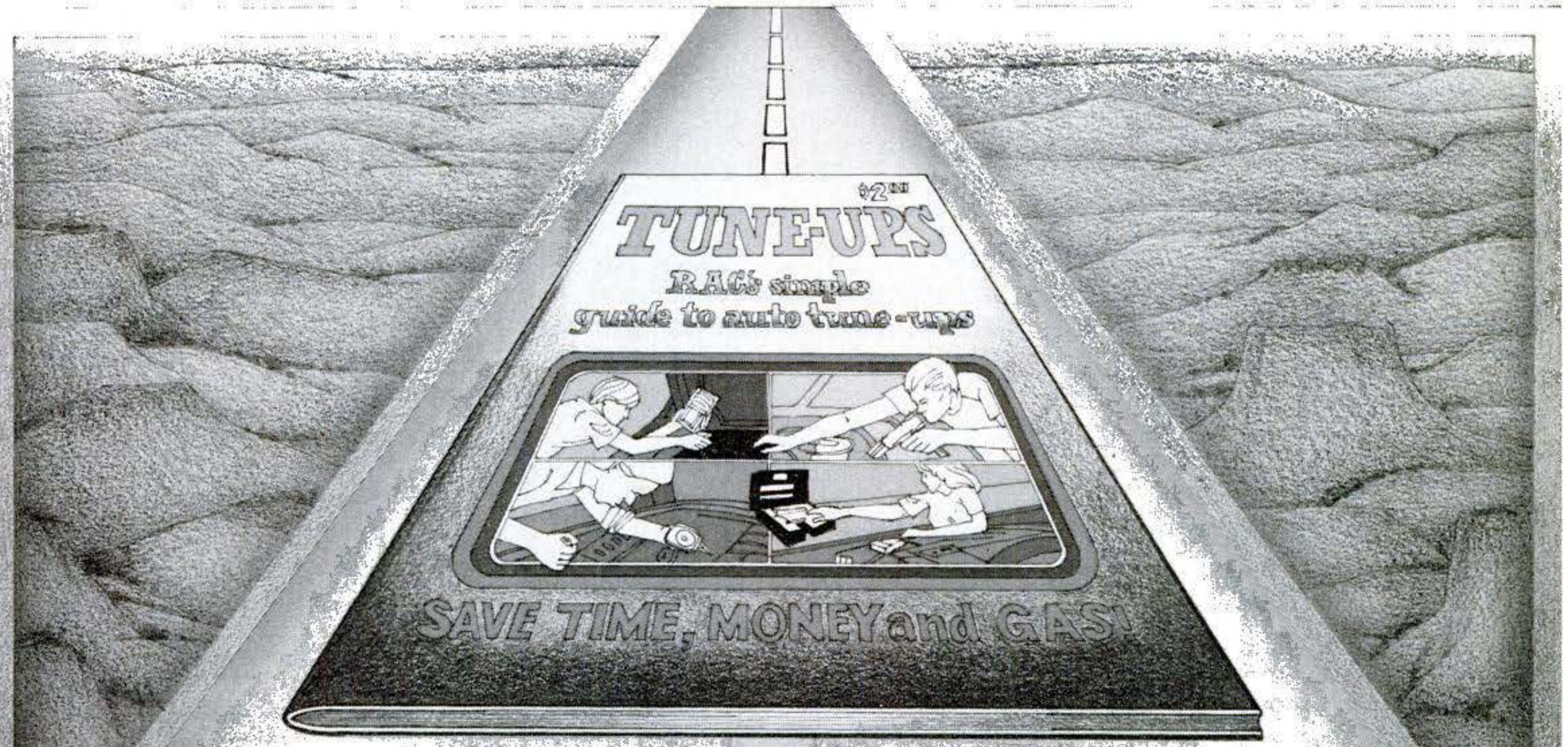

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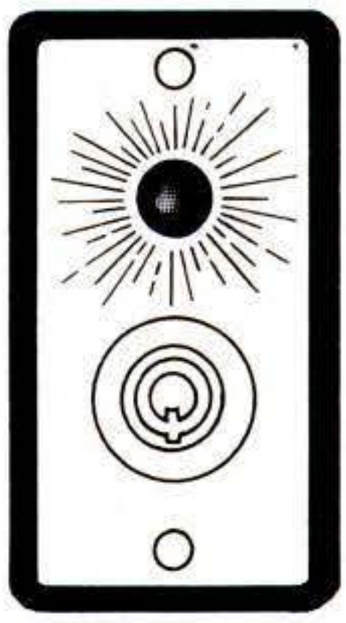

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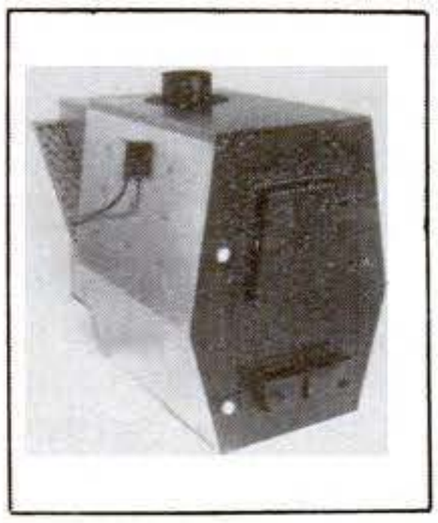

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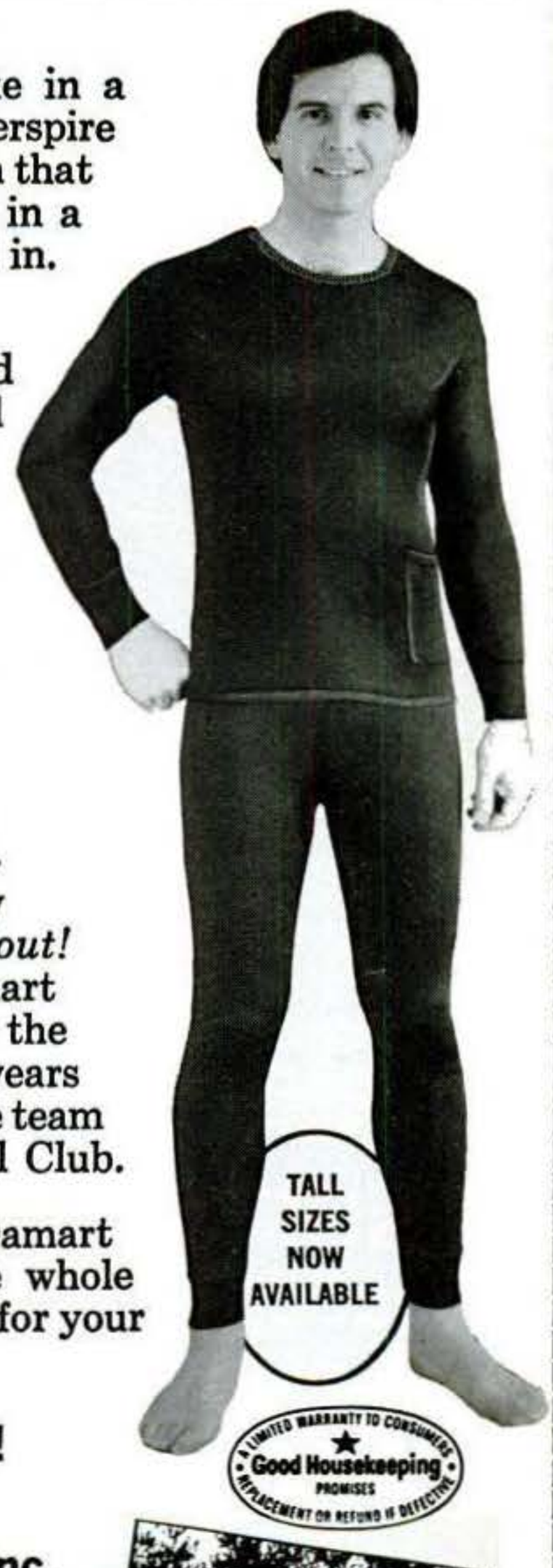

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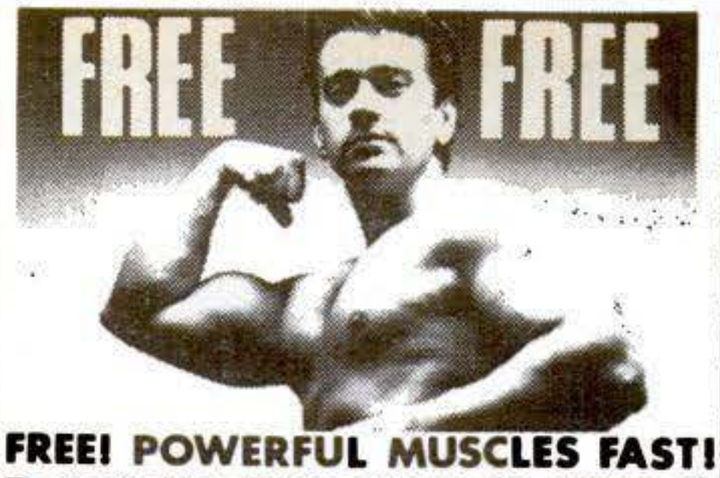

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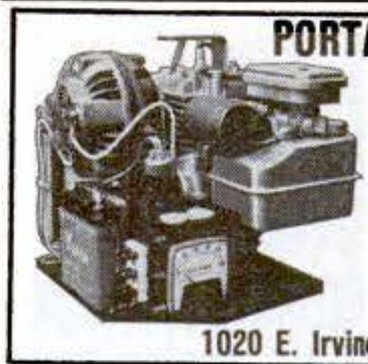

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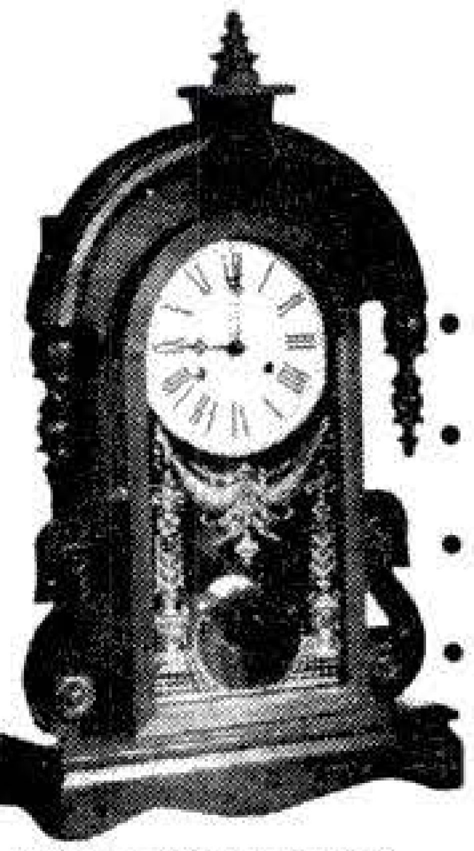

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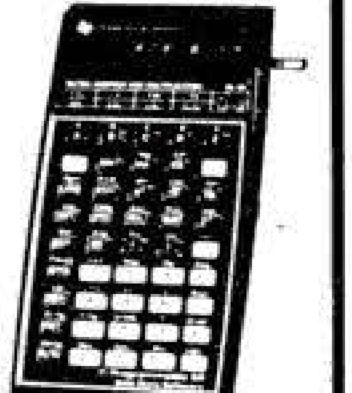

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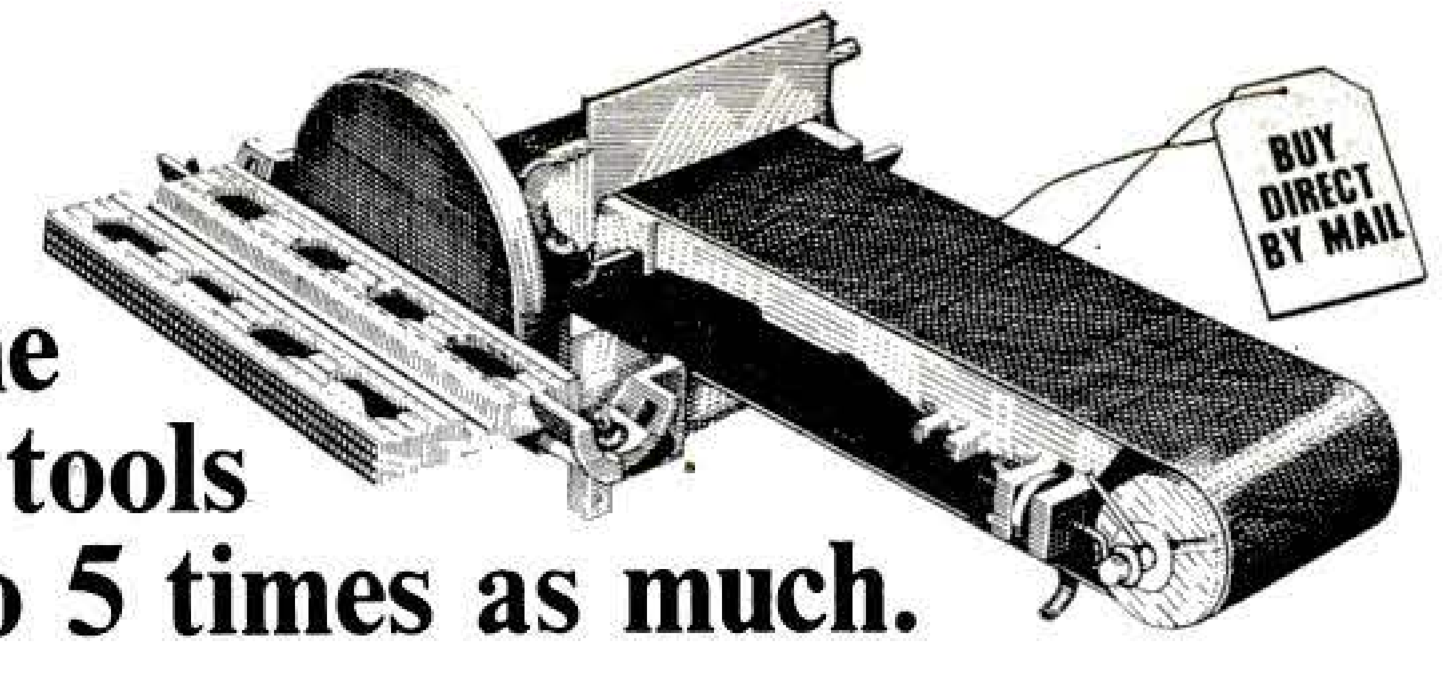

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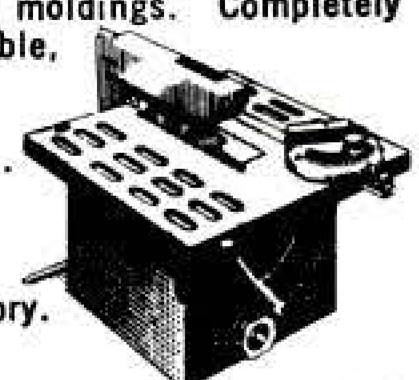

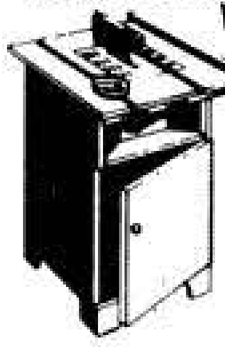

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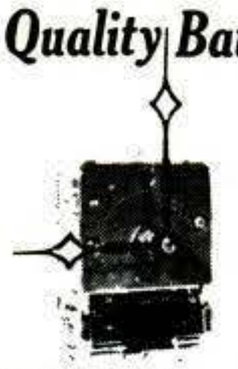

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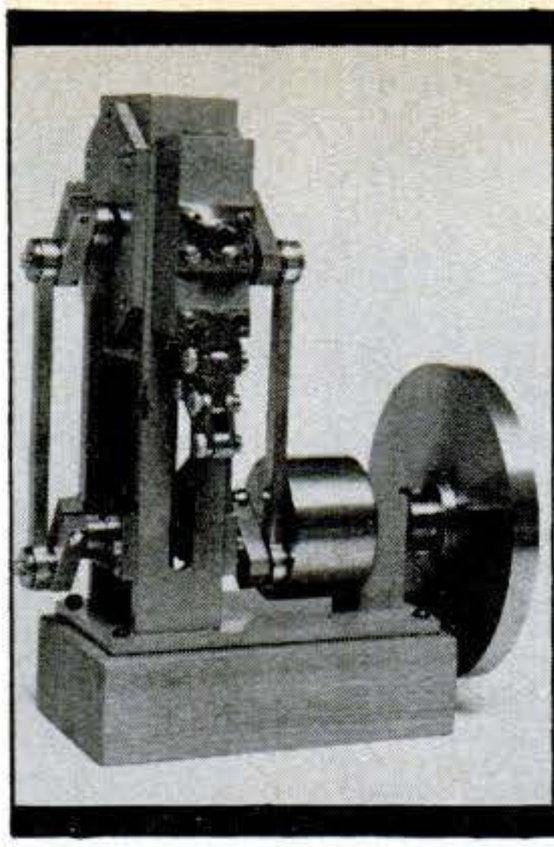

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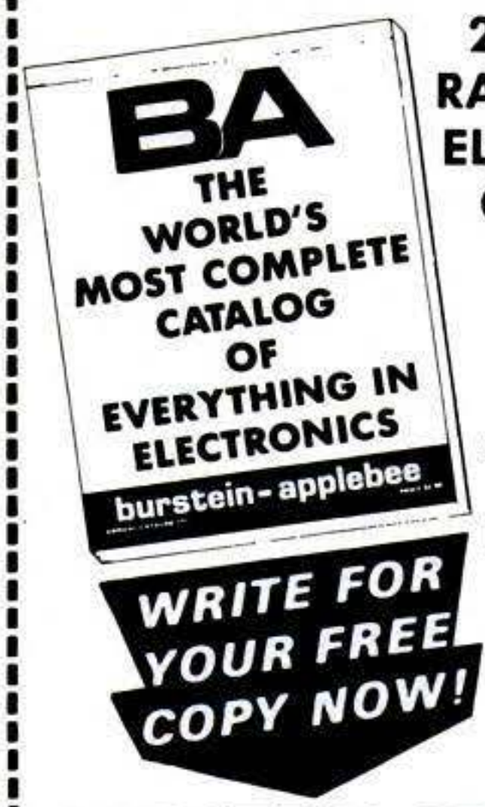

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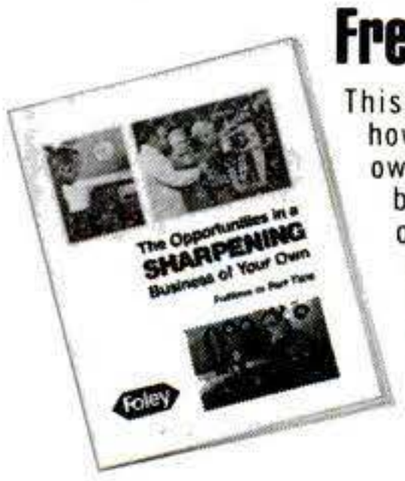

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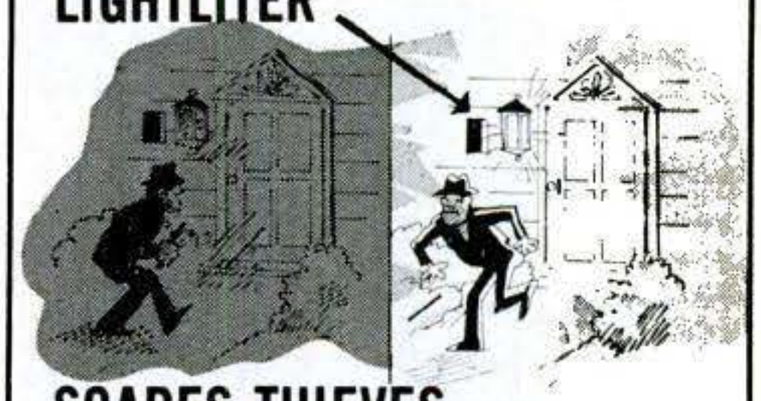

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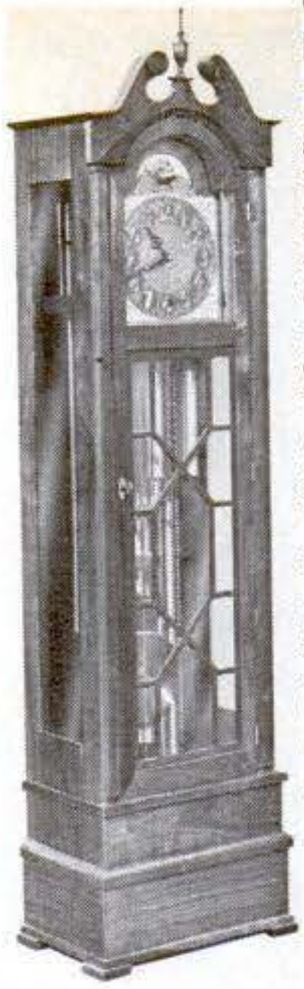

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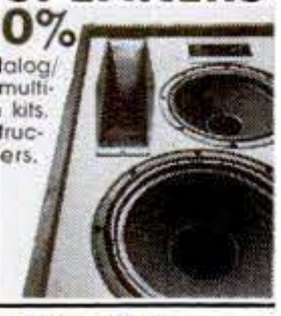

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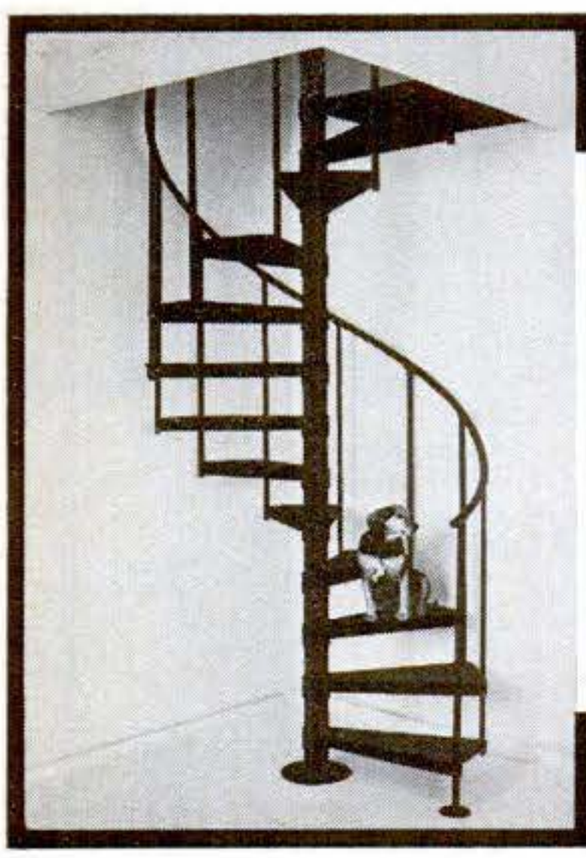

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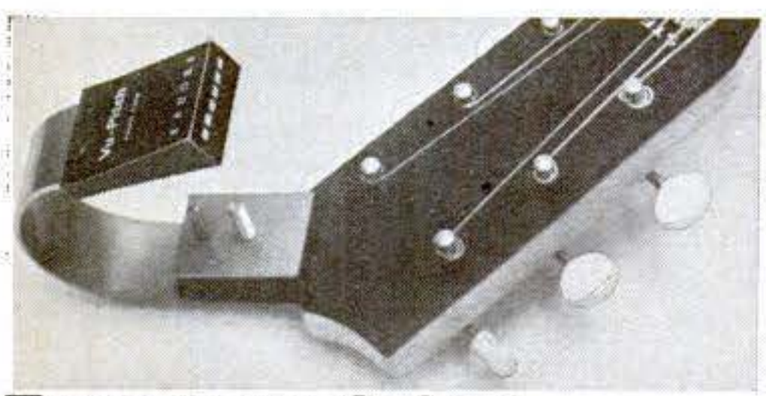

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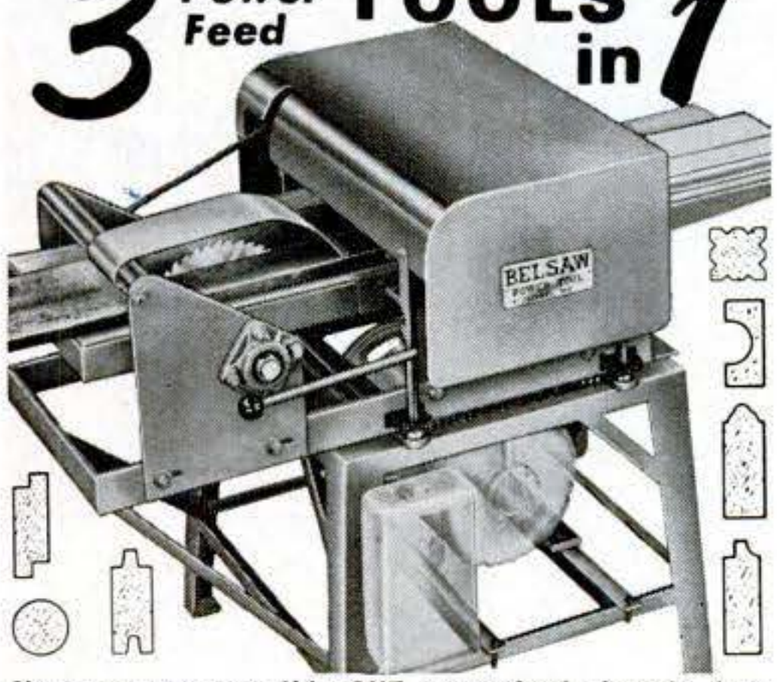

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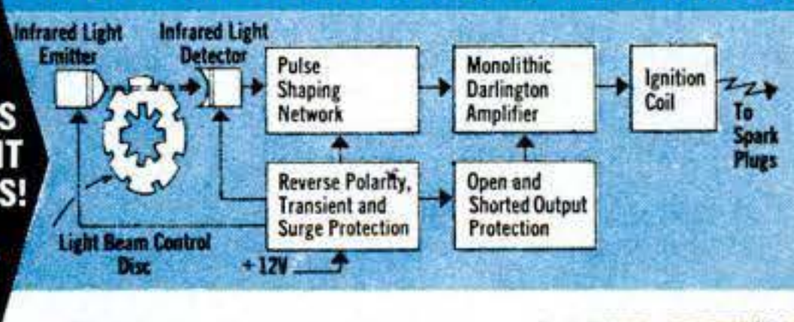

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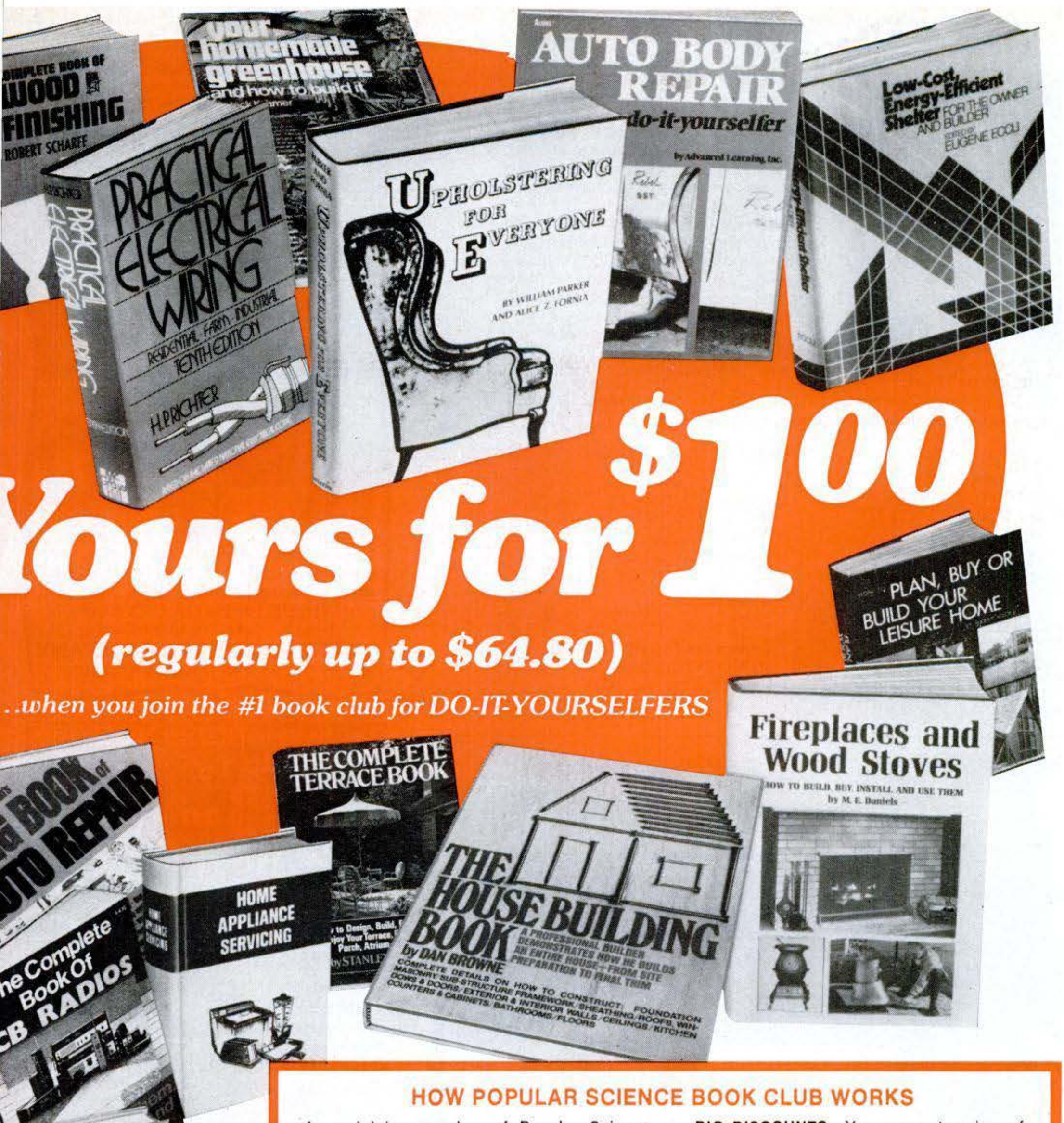

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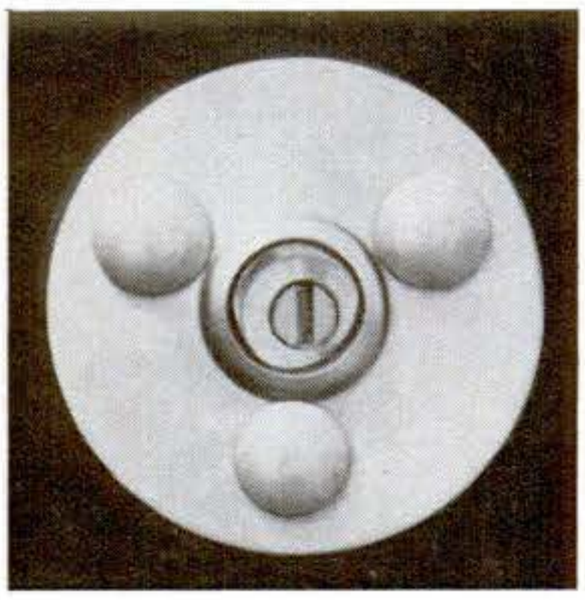

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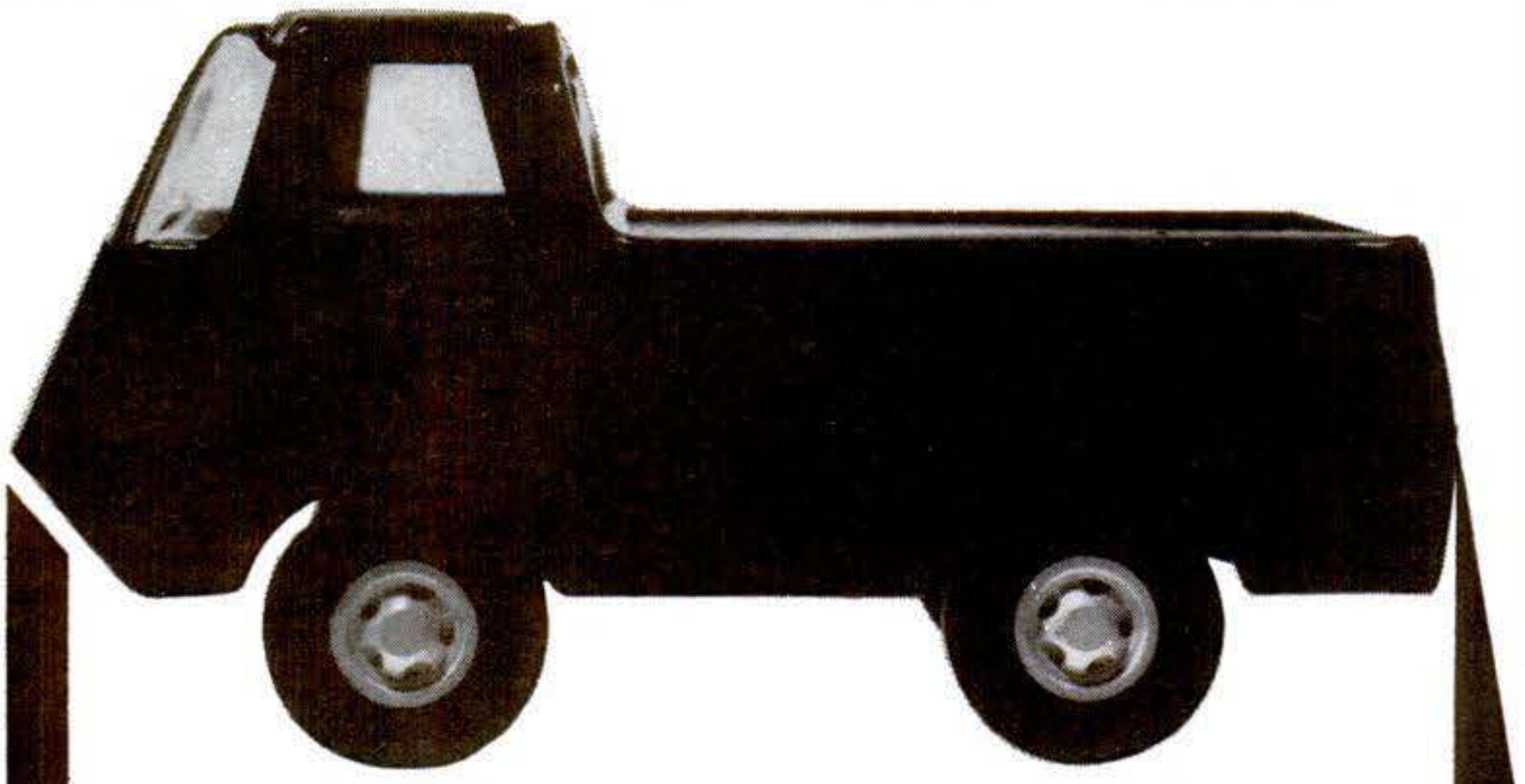

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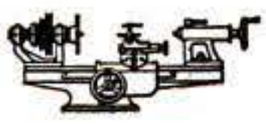

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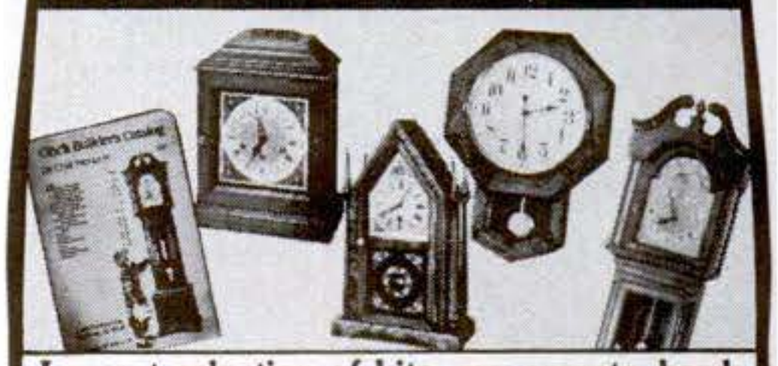

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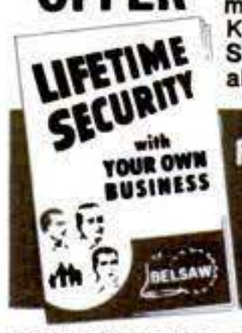

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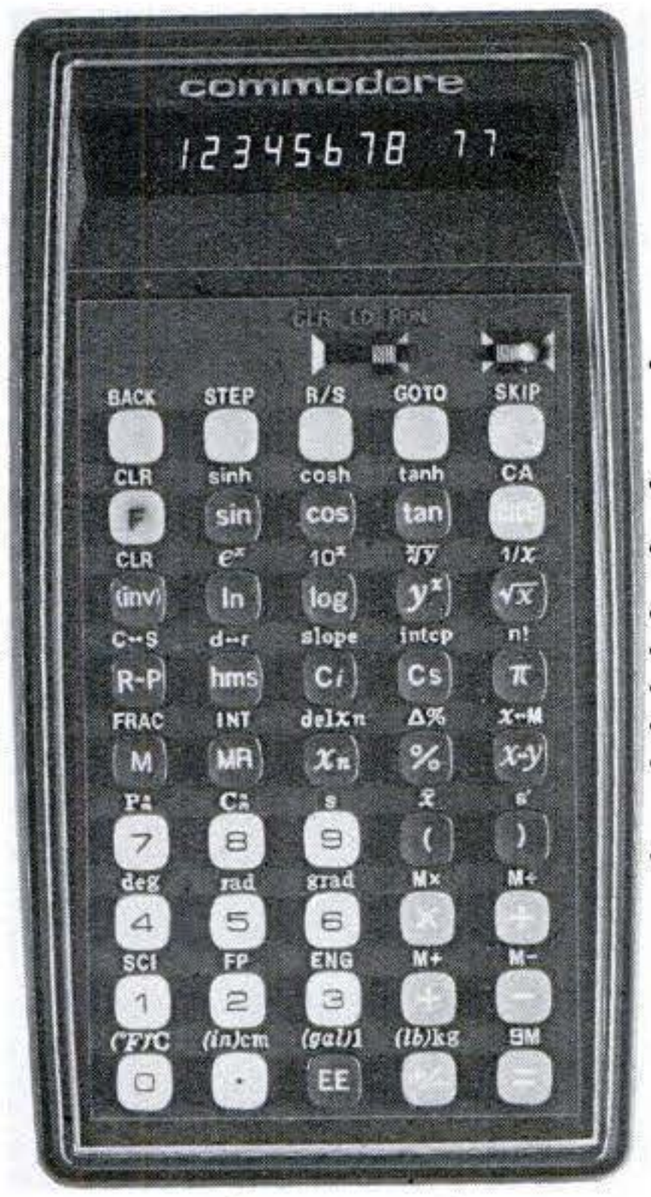

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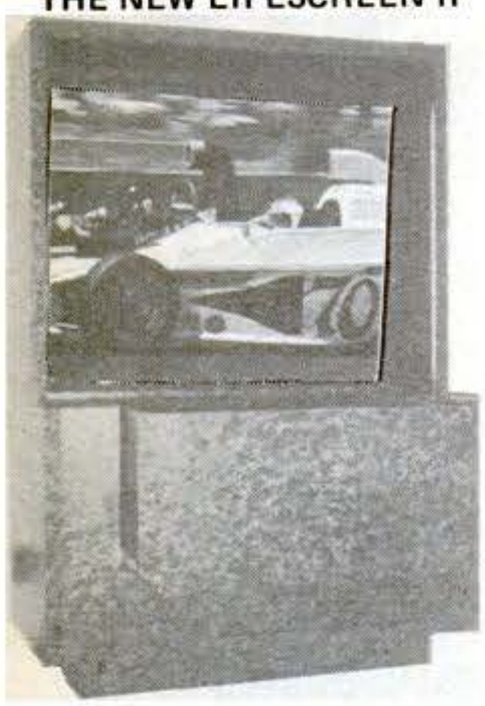

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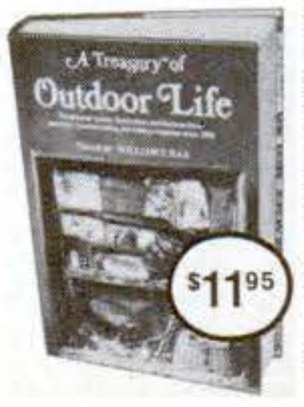

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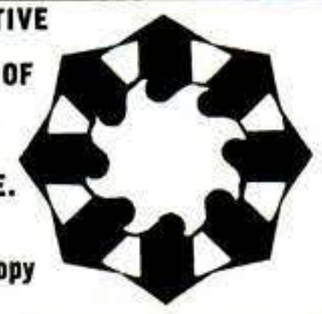

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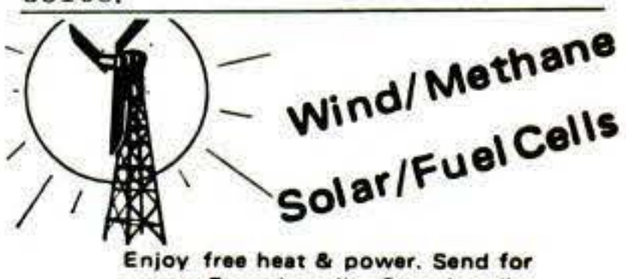

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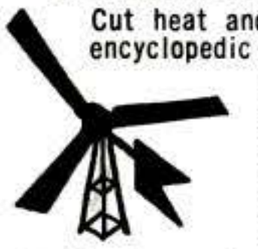

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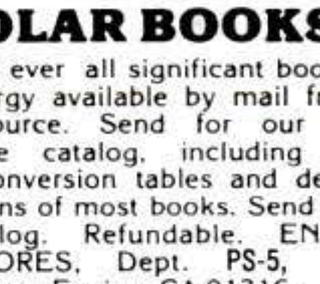

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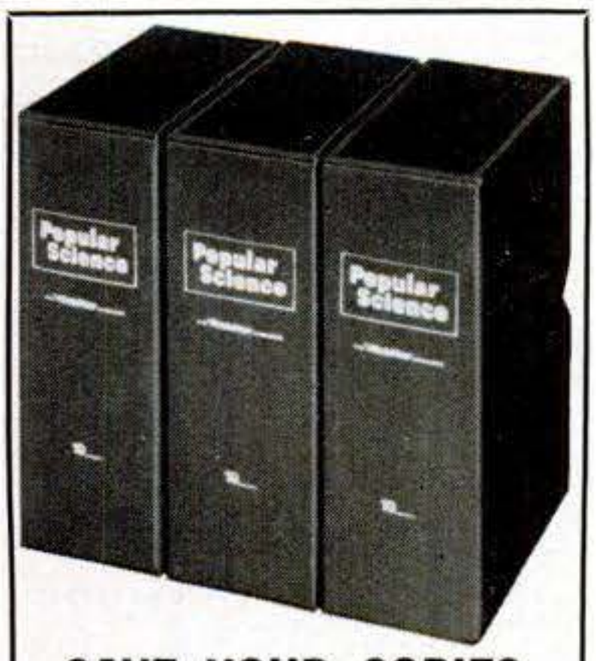

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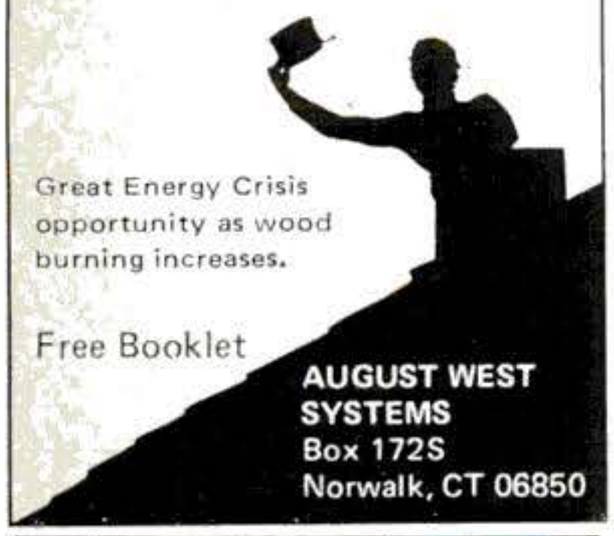

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Popular Science product information

Booklets, catalogs, and folders listed below provide reliable information, illustrations, and specifications to help you in planning the purchase of a variety of products or services offered by these dependable companies. The convenient order form will save you time and postage.

915 Information Guide to Bernzomatic Torches
An eight-page illustrated booklet outlines the many repair and hobby projects made easier with a torch. A valuable guide helps you select the most economical torch for your needs. Free

916 Roofing and Siding Brochure
Thirty-six page color brochure describes roofing, vinyl siding, and shutters designed to make your home's exterior maintenance-free. Illustrations of how six architectural styles can be updated. From Bird & Son, Inc. 50¢

917 Design-A-Deck Kit
Build a redwood deck to fit your home and yard. Twenty-page manual and unique "punch-out" deck patterns for a one-of-a-kind deck. From California Redwood Assoc. $4

918 How To Choose and Care for Household Cutlery
Handy brochure describes different types of knives and their uses, what to look for in buying quality knives, how to sharpen and care for them. From W.R. Case & Sons Cutlery Co. 25¢

919 Fishing Lure Catalog
Sixty-eight pages of freshwater and saltwater lures, South Bend baits, flies, snaps, swivels, and hooks. From Glen L. Evans. 50¢

920 Evinrude Parts Catalog
Catalog shows exploded views for proper assembly sequence and describes factory-approved parts. $2.00

921 Rust Prevention Brochure
Colorful three-fold brochure describes a new breakthrough in rust prevention, Ferrothane plastic finish with Rustaid. No primer is needed; it's good for use on any metal subject to rust or corrosion, says Flecto. Free

922 Herman's Footwear
Color brochure features famous Herman Survivor boots and other outdoor footwear for men and women. Free

923 Hyde Manufacturer's How To
Twenty-four pages of drawings show how to prepare surfaces for painting, decorating, and restoring projects. Brochure includes dozens of other time-saving decorating tips. 50¢

924 Jacuzzi Marine Booklet
Twenty-four page illustrated color booklet describes the manufacturing and organizational structure for its marine jet drives, plus the history and development of the product. Free

925 Jayco RV's
Descriptive color literature sets the mood for travel adventure in Jayco RV's: fold-down campers, travel trailers and mini motor homes. Free

926 Home Insulation
Johns-Manville guide for do-it-yourself home insulation describes various insulation products and tells where and how to install them for the best results and greatest economy. Free

927 Motor Homes
Booklet from King's Highway motor homes describes construction, equipment and different models. These motor homes contain almost all the amenities necessary for luxurious traveling and vacationing, says the maker. Free

928 Planning a Home Laundry Center
Revised and illustrated 20-page booklet describes laundry-center design, location, storage and work space. Also included is information on a kitchen-cleanup center. From Maytag Co. Free

929 Engine Oil Coolers
Booklet explains advanced-design full-flow engine-oil coolers. From Mesa Corp. Free

930 Bricks and Panels
Modern Methods brochure illustrates brick, Brickette floor brick and mini-panels. Color charts, decorating tips, and installation photos are included. Free

931 Hustler Antenna Patch
High-quality, bright blue and white, two-by-four-in. oval emblem can be worn on jacket or cap. From New-Tronics. 75¢

932 Track Lighting Catalog
Linear-power lighting with exclusive track. Full-color catalog has room illustrations of unique models. From Nutone Div. of Scovill. $1.00

933 CB Specs
Color sheet gives technical specs on Tiger 40 CB and shows operating capabilities of new 40-channel Pearce-Simpson CB for cars, trucks, boats, RV's. 10¢

934 Energy-saving Fireplace
Preway's color brochure features wood-burning, freestanding, built-in Energy Mizer fireplace. Includes drawings, chimney information, photos and instructions. Free

935 Underground Lawn Sprinklers
Brochure shows how to install permanent underground sprinkler system with a minimum of sprinkler heads and digging. Four sprinklers cover the same area as 24 conventional heads, says Rain Jet Corp. 25¢

936 Practical Firewood Guide
"How to Select, Cut and Season Good Firewood" covers everything from tree identification to equipment selection; includes tips on finding free wood, cutting it safely, transporting, seasoning, and burning. From Stihl, Inc. 50¢

937 *Homeowner's HOW TO Handbook*
Current issue of *Popular Science*'s new and valuable source of expert advice to homeowners on how to repair, remodel, and maintain their homes, and keep their lawns and gardens attractive. $1.50

938 Woods of Weyerhaeuser
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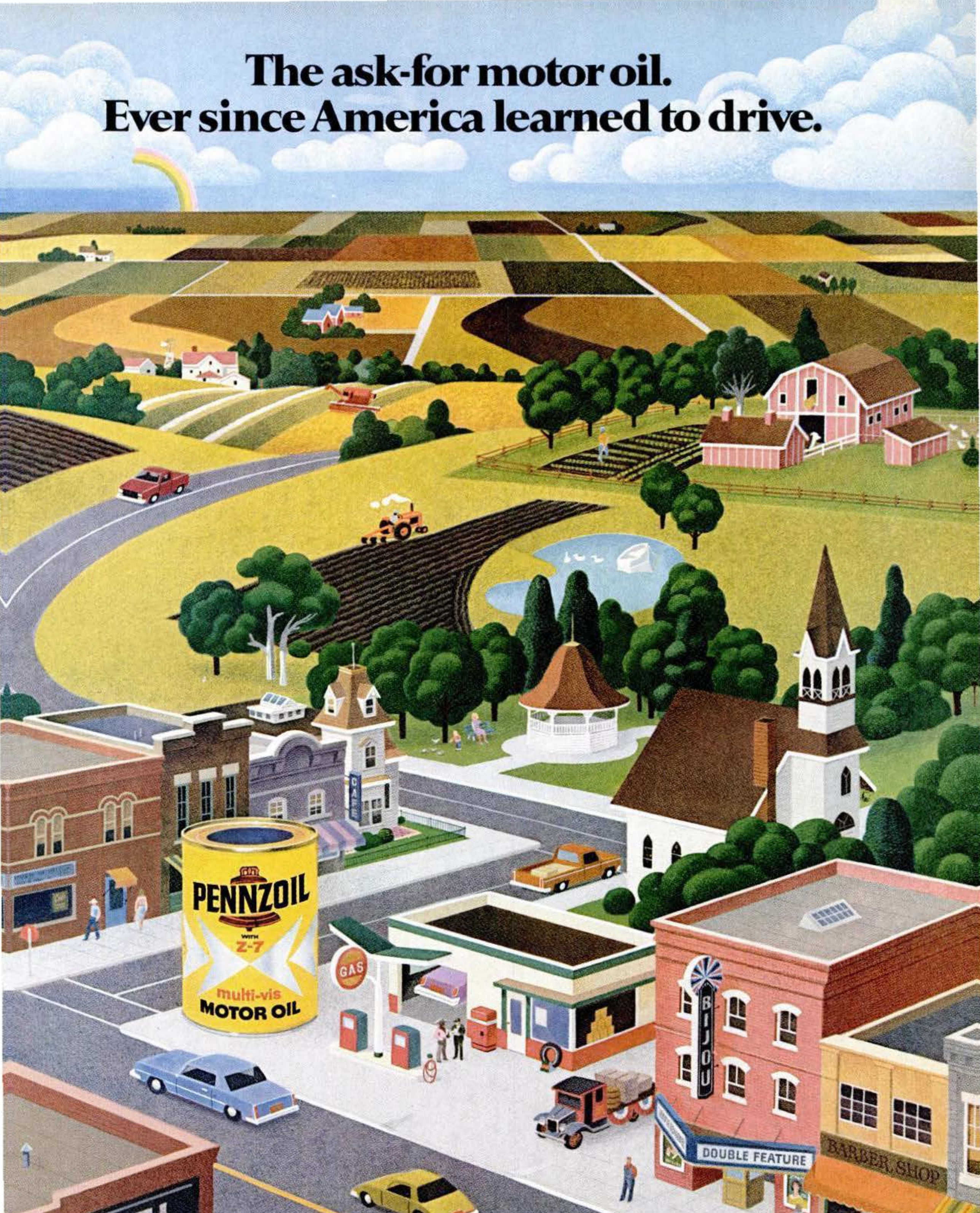

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